Australia's Electronics Magazine

SILICON CHIP

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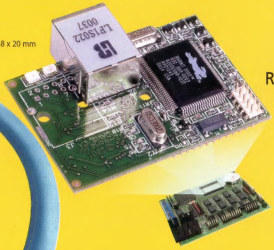

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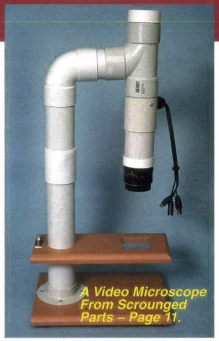

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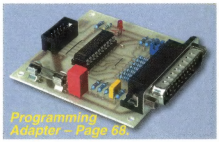

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PUBLISHER'S LETTER

Australia is still the lucky country

Who does not still believe that Australia is the lucky country? Apart from wonderful climate and stable government we have a strong economy. That last factor is all the more favourable considering that much of Asia and most of the western economies appear to be heading into recession. Asia has been particularly hard hit and the USA appears about to go through a year or so of very low growth. And Japan, once the powerhouse of Asia, seems unable or unwilling to sort out the problems in its economy so it won't contribute much to growth over the next few years either.

Which brings us back to Australia. Remember all those commentators who said that the Australian dollar was undervalued because we are perceived to be part of the "old economy" rather than the exciting "new" economy? And remember those politicians and commentators who said that Australia had to become the "clever country" and invest more in IT manufacturing and all that? We didn't, did we?

It turns out that most of those high-tech products are now in gross oversupply: computers, mobile phones, DVD players and virtually any other electronic consumer product. And it does not take much thought to realise that this was always going to be the case. It's a good thing that Australian companies did not take that route otherwise they would be really languishing now. The much-vaunted tech revolution and e-business companies look pretty sick at the moment.

Meanwhile, Australia is doing pretty well thank you and it's not all due to our low-valued dollar. Although, as I wrote back in the December 2000 issue, the longer that the Australian dollar remains undervalued, the better, because it gives our exporting companies a massive advantage.

Even in the current slow world economy, the people of other countries still need to eat, buy clothes, etc, so they will continue to buy our primary products exports and a lot of our manufactured goods and services as well.

And while Australian companies have not invested at all in the mainstream consumer IT products and telecommunications, many smaller companies are doing very useful research and development in "niche" products. Also very encouraging is the fact that most of the Australian capital cities have encouraged the development of technology parks which act as a hothouse to push R&D. At some stage all this investment will really pay off for Australia.

Yes, we would all like to see some more major Australian technology companies such as CSL, Cochlear, Aristocrat and so on, but lots of smaller technology companies exporting will do just as well thank you. Australia still is the lucky country.

Leo Simpson

Footnote: all of us at SILICON CHIP express our deepest sympathies to all those affected by the terrorist attacks on the USA, which occurred just as this issue went to press.

MAILBAG

STC A-141 is not a reflex set

I refer to page 96 of the Vintage Radio article in the June issue of SILICON CHIP. The circuit shown is described as a 4-valve reflex set, however there is definitely no reflexing. It is a straightforward superhet with no first audio amplifier. Obviously there is sufficient signal developed across the diode load PI to drive the speaker via V3. There were many sets manufactured with circuits similar to this one.

There were also many reflex sets whereby the detected audio was fed into the grid of the 6G8G IF amplifier via the first IF transformer coil and the audio extracted from resistor in the B+ feeding the 6G8G plate via the second IF. Thus the 6G8G becomes both an IF and an audio amplifier. Some of these sets did have problems with audio distortion etc.

Ted Baker,
Bathurst, NSW.

Comment: You are right. The A-141 was not reflexed whereas the B-141 and C-141 were reflex sets. The person who sub-edited the story wrote the caption and made the mistake.

5-minute Araldite not recommended

I have just been reading the July 2001 issue and wish to thank you for such an enjoyable and well-produced magazine. There are several things I would like to comment on, if I may. First, some of the projects in your magazine feature PICs. Unless these projects are offered as kits, readers who do not possess a computer cannot build them. Indeed, there are one of two projects featured recently that we would like to build but cannot.

Secondly, in the Vintage Radio column, Mr Champness suggests using 5-minute Araldite in the repair of Bakelite cabinets. In the book "Electronic Classics" written by Andrew Emmerson, he writes: "... five minute epoxies produce quite brittle joints and should probably not be used where thermal expansion is likely (eg, in a valve radio cabinet, my addition). The 24-hour epoxies are far more flexible when cured."

On another subject, in the December 2000 issue, one of the projects featured was a LED Torch. We have built several of these from kits with varying degrees of success. As such, may we please offer the following construction hints:

(1). The first thing that should be soldered to the PC board should be the PC pins and the M3 washer adjacent to Q1. If left until later, heat from the soldering iron will "cook" Q1.

(2). The wire link from Q1 to the 330pF capacitor should be fitted next, otherwise it may prove impossible to fit if Q1's body covers the mounting hole.

(3). The kit includes an M3 washer intended to be mounted adjacent to the 4.7µF capacitor We can't really see the need for this. All it seems to do is slice through the insulation surrounding the leads to the LED thereby shorting them with results that can be imagined!

T. Robinson VK3DWZ,
Woodend, Vic.

Comment: programmed PICs for SILICON CHIP projects can be obtained from RCS Radio Pty Ltd, 41 Arlewis Street, Chester Hill, NSW 2162. Phone (02) 9738 0330. ***www.cia.com.au/rcsradio***

Component availability

I have taught private hobby electronics classes on and off over the last five years, mainly to senior primary and junior high school children. Almost always, each group of participants has started with an easy to make crystal radio set, as a primer, just to let them and their parents know what they're getting themselves into. While this project has taken on different design formats over the years, the basic outline is still there.

I now find that some of Australia's major electronics hobby suppliers have gone out of some of the parts required for even such a simple project. I haven't been able to buy all of the items from one supplier for some time now and, lo and behold, when I open up some of the 2001 catalogs, I find that their entire range of ferrite products (ie, rods, balun cores and aerial coils) are missing. Jaycar seems to be the only retail supplier who, at this point in time, have enough "bits and pieces" available off the shelf.

Maybe some people will see this as a bit of a storm in a teacup but after being in the hobby for 32 years and having been in communications and business machines for 15 of those years, I think that there is a danger that many younger people who would otherwise made a start via simple projects may well be turned off by the latest batch of "computer gizmos" that have all but replaced them in some catalogs. If you think that crystal sets are out of date, do a web search (eg, **www.midnightscience.com** plus links, etc).

I think it's a bit strange when major suppliers import kitsets from other countries, when there's more than enough hardware and know-how staring them in the face down at their own warehouses.

A. Hellier,
Warilla, NSW.

More comments on poor DVD quality

I was at a friend's house recently to see his new you-beaut Fujitsu plasma display. The aspect ratio was 16:9, 1.5m wide. The unit was running in XGA mode and he tells me it has 1,000,000 * 1,000,000 pixels.

My friend played a couple of DVDs ("6 Days, 7 nights" and "As Good As It Gets"). In bright scenes the image was

very good, however I must admit the picture quality of some scenes with this monitor's resolution was dreadful.

Backgrounds were very poor indeed, especially night beach scenes and those where Harrison Ford is trying to deal with the wild pig in the lake scene of 6 Days. The only comparison I can draw is switching one's computer monitor to 256 colours.

The general impression of the image was that it was continually digitally "raining" on the picture (this can sometimes be seen even on an analog TV set with an off-air signal). When I commented on the poor picture quality he said "Yes, that's DVD for you. If you want to spend between US$8,000 and US$10,000 you can get a player which will rebuild the picture back close to what it was on the film".

Even my 15-year old son was appalled at the picture quality from these DVDs on this monitor. Our general consensus was that the lack of picture quality and digital rain was really annoying and at times unwatchable.

DVD is being touted by sales personnel as the "ant's pants" video system. Obviously from what I saw recently, it's not. Am I correct in stating that we have a current system which is better than VHS but still poor quality when compared with film? Do you know if there are plans in the offing to bring in a newer system which will replace the current MPEG compression system used on DVD?

I must admit that, after this experience, I'm totally disillusioned with DVD.

Brad Sheargold,
Collaroy, NSW.

200 watt Mosfet amplifier

With regards to the 200W Mosfet audio power amplifier in the August 2001 issue I noticed that the distortion performance is not exceptional and wondered if there could be a reason. In the high current circuitry, the PC board layout violates a few rules of good practice as mentioned by British power amplifier expert Douglas Self and others. Where heavy currents, such as ripple currents to the power supply reservoir capacitors and the class B audio currents to the load are flowing through printed board tracks or indeed, ordinary wiring, it is not sufficient to assume that they have no resistance.

Of particular interest is what happens when a division of current occurs such as the power transformer centre tap carrying ripple current to one reservoir capacitor and then the other. As this lead is the 0V or power supply centre point we need a high degree of symmetry in the wiring for it to be a "quiet" 0 volts. This is sometimes called the "star point" where C2+, C3-, C4-, C5+, transformer centre tap, and the outgoing 0V lead should converge. Another place where heavy currents divide is between the load (speaker) and the two halves of the output devices.

The negative feedback should be taken from the true output track and not from the track to one or other of the output devices where track resistance is likely to impart an asymmetrical voltage drop to the signal on one half cycle. Likewise the Zobel network C12, R22 should be wired to the output terminal and returned to the 0V terminal rather than part way along the ground connection for C16. The star layout is relevant here also.

Keith Taylor,
Hawthorn, SA.

Comment: this contributed design was presented as a reliable and affordable workhorse rather than as a very low distortion amp. If the amplifier had been one of our designs, the PC board would have more along the lines of what we used in the Plastic Power and Ultra-LD amplifier modules.

Electricians should document their installations

I want to comment on that bad old electricity argument! What I've witnessed in Mailbag to date is emotional. I ask this question: if laws are in place, will that stop unlicensed individuals undertaking electrical work? I think not. And if the unlicensed individual works for a large consumer organisation repairing VCRs, is the large organisation going to stop them doing so? I think not, because that organisation as part of their due diligence processes should be ensuring that the individual is undertaking the appropriate work practices to ensure they don't injure themselves.

I don't believe the electrocution problem will ever be solved, irrespective of licencing laws. I am a licenced electrician, though I don't practice much these days and yes I've had severe electric shocks a number of times both because of my own stupidity and that of others.

My background is electrical and electronic controls, and I have undertaken plenty of domestic installations. I won't deliberate on the problems I've encountered. What I will say is that if all the people who work on an electrical installation did their job properly there wouldn't be an issue.

What I do have a problem with is when someone completes an electrical installation without leaving enough information, so the next individual who undertakes a modification to the installation doesn't need to spend half of their time working out what has been done - and then, if need be, fix any bad workmanship prior to undertaking the job.

Completing an installation is only half the job. Documenting what has been undertaken is the other half. In the commercial area of the electrical industry, it is mandatory due to industry/client requirements that the installation is usually properly documented; ie, schematic diagrams, switchboard layouts/locations, properly labelled outlets, etc. And even then a lot of these are not 100% correct (I've had the displeasure of working on some of these installations). The installations that are properly documented occur because the client won't pay the contractor until adequate documentation is provided.

On all the domestic installations I've worked on, I have not once witnessed documentation that adequately defines the installation. If any licenced electrician believes that a diagram drawn in indelible pen on the bakelite back board on the meter enclosure and labelled circuit breaker/fuses adequately define the installation they have to be kidding!

When I've completed an installation, I provide the client with documentation defining what I have done. As a minimum, there should be a plan of the installation defining: lighting, fixture and outlet locations; circuit ratings; and wiring paths. This should

be a regulatory requirement for all new installations and local councils should be enforcing this as part of the final inspection processes.

Mal Land,
via email.

Comment: We thoroughly agree with your comments on documentation.

.

More on the electric wiring debate

To comment on the electrical wiring debate, I need to throw a couple of items into the ring:

25 years ago, a "professional" wired an extension on my home. He tightened only two out of three screws on the back of each power point. The electrical noise on AM radio was horrendous and three power points burnt out in less than six months. The Licensing Authority told me that they could prosecute me for removing a power point from the wall but would take no action against the electrician as he had a licence!

In the ACT, a plumber can get a "Restricted Licence" on proving competence! The plumber can then connect new Hot Water Services right back to the main distribution board. With this licence, however, a plumber cannot change a power point at his own home.

Brian Wilson,
Curtin, ACT.

Not all technicians deal with low current

I have been reading with much interest all the letters relating to the debate about non-qualified people performing their own wiring and the view that technicians, despite their qualifications, should not be licenced as electricians. What has really egged me however, is the 'sparkies' stereotypical portrayal of techs. Mr Raffaelli's parting comment in his letter in the September 2001 issue was the straw that broke the camel's back and prompted me to write this letter.

Not all techs are involved in small signal work or deal with less than 0.5A. In my 13-year career as a radio/electronics technician, I have worked on radar systems that are fed with 415V 3-phase and generate in the final stage 60kV at 8A feeding a magnetron that develops 2.4MW of microwave energy! Does that require a different mindset? Or how about a 10kW HF transmitter that has a final plate current of 80A?

Matthew R Clarke,
Darwin, NT.

More on the widescreen "scam"

Simon Kareh has raised some very important points in the September 2001 Mailbag. I'm one of the disillusioned DVD buyers as well – the Claytons widescreen, or 'scam-screen', I call it. You get it on TV (FTA) all the time. The stations can't decide how much to crop, so they adjust it on the run, especially at night when the Tea-Lady is in charge. I've seen the ABC do it mid-interview and crop off heads, etc. I believe the whole thing is a conspiracy to save bandwidth.

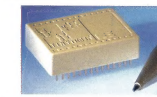
The FTA stations could send more data in their wretched MPEG format between transmitters if 44% of the lines aren't coded with anything but black? The same on the DVD discs. It is scam-screen, saving heaps of data space on the DVD. Who would buy a new 16:9 TV? Not me, so I can have my 281 lines blown up on a 'wide-screen' set.

I have owned a DVD player for two years and guess how many DVDs I own? Not one, because the format was over-hyped and under-delivered. Where are the camera-angles promised, the switchable widescreen/pan and scan and the fast access promised? Most new movies won't let you skip tracks until their 'startup program' is finished. I still hire VHS over DVD – the sound quality is as good (good quality Pro-Logic off a hifi soundtrack is great) and my 71cm set doesn't look like two 34cm sets side by side.

I don't even use the DVD player for CDs any more. I got an old CD player and repaired it. It works more efficiently – no time spent deciding whether a DVD or CD is inside it. It's just another attempt at consumer manipulation for profit, not improvement. We're losing analog TV, we lost the best analog mobile network in the world and what's next? Amateur bandwidth, AM radio, UHF CB?

John Richardson,
via email.

The Tiger comes to Australia



The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

TIG505 Single Board Computer

The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

$330 PC-PROM Programmer

This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software.

Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.

JED Microprocessors Pty Ltd
173 Boronia Rd, Boronia, Victoria, 3155
Ph. 03 9762 3588, Fax 03 9762 5498
www.jedmicro.com.au

Run RABBIT Run

Rabbits usually have long ears, four legs, lots of fur and can run very fast. This earless rabbit has 100 legs, no fur and runs much faster than a Z180 microprocessor.

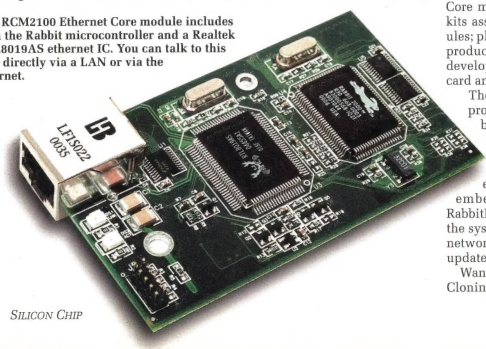
So is this some form of super mutant rabbit? Nope – it's a microprocessor that runs rings around the old Z180 but uses an updated Z180-style instruction set to make things easy for experienced Z80/Z180 assembly language programmers.

If you can program a Z180, you can program this baby! – or should that be bunny?

Going back in time, the Rabbit 2000 Microprocessor was first let out of its hutch by Rabbit Semiconductor in the US in 1999 and immediately spread out, recently arriving Down Under after a long swim across the Pacific. It's a robust little critter that's completely unaffected by the Calisi virus and is supported by several very impressive development kits that include the Dynamic C programming language.

And no, that's not a trial version of Dynamic C – it's a fully-working version that's supplied with the core modules and the development kits.

The RCM2100 Ethernet Core module includes both the Rabbit microcontroller and a Realtek RTL8019AS ethernet IC. You can talk to this unit directly via a LAN or via the Internet.



What's in the burrow?

There's more than one Rabbit running around in this warren. Apart from the Rabbit 2000 microprocessor itself, there's also the Rabbit 2000 and RabbitCore 2000 development kits; the RabbitCore RCM 2100 & 2200 Ethernet Core modules; the two development kits associated with these core modules; plus a host of other Rabbit-based products, including the "Jackrabbit" development board, the "RabbitLink" card and the "Rabbit Cloning Board".

The "RabbitLink" card lets you program and debug your Rabbit-based system via a network or the Internet – see Fig.1. What's more, an inbuilt miniature web server and SMTP client can be controlled by any embedded system via the RabbitLink's serial port. This allows the system to send information to the network using either email or easily-updated static HTML pages.

Want to breed Rabbits? – the Rabbit Cloning Board lets you do just that. It

copies compiled software programs from one Rabbit 2000-based board to another without the need for a PC.

Rabbit stew

The main ingredient in the Rabbit stew is, of course, the Rabbit 2000 microprocessor. This is a high-performance, 8-bit microprocessor with a "C-friendly" instruction set, fast number crunching ability and numerous on-chip peripherals. It boasts four serial ports, a slave port, remote bootstrap capability, advanced clocking options (five 8-bit timers & two 10-bit timers), and "glueless" interfacing to both memory and I/O – making hardware design easy.

(Note: "glueless interfacing" means that all the interface logic is built into the microprocessor).

This Rabbit is fast, with clock speeds up to 30MHz. And because it's optimised for a C-oriented instruction set, the 8-bit Rabbit 2000 is claimed to be a viable alternative to existing 16-bit and 32-bit processors in many situations but at a much lower cost. It runs about three times faster than the Z180 for the same memory speed when running C code.

In practice, you can load up to 50,000 or more lines of Dynamic C into the Rabbit's 1MB of code space. The Dynamic C provides an interactive compiler, editor and source-level debugger and eliminates the need for external emulator hardware. Numerous application libraries are also included, thereby shortening development time and making programming easier.

The RabbitCore RCM2100 Developer's Kit includes an RCM2100 Ethernet core module with 512KB of flash memory and 512KB of static RAM; a prototyping board; an RS232 programming cable (10-pin header to DB9); a Dynamic C SE CD-ROM (includes royalty-free TCP/IP stack with source plus complete product documentation); a plugpack power supply; and a "Getting Started Manual".

The instruction set

The Rabbit 2000 features an updated Z180-style architecture for improved performance. At the same time, a number of obsolete Z180 instructions have been dropped to allow efficient 1-byte operation codes for new instructions. This means that existing Z180 assembly language programs can be ported to the Rabbit 2000 with minimal changes.

New "C-friendly" instructions are included for fetching and storing 16-bit words located at a computed memory address or on the stack. These new instructions perform fetches, stores, calls, returns and jumps over a full megabyte of address space.

The new instructions are claimed to improve communication between

Programming The Rabbit With Dynamic C

The supplied Dynamic C for the Rabbit 2000 includes a powerful editor, compiler, linker, loader and debugger, along with hundred of functions in source-code libraries.

In fact, compiling, linking and loading are all one function. Dynamic C does not use an in-circuit emulator (ICE) – instead, programs being developed are downloaded to and "executed" from the "target" system via the serial port connection.

This makes for faster program development and debugging of errors. Breakpoints, single stepping, observation of variables in a running program, complex watch expressions and "printf" commands to the Dynamic C console are all supported to aid debugging. Other features of Dynamic C include:

(1) An easy-to-use inbuilt text editor. Programs can be executed and debugged interactively at source-code or machine-code level. Pull down menus and keyboard shortcuts for most commands help make Dynamic C easy to use.

(2) Dynamic C supports assembly language programming and it is not necessary to leave C or the development system to write assembly language code. In addition, both C and assembly language can be mixed together.

(3) Dynamic C provides extensions to the C language (such as shared and protected variables, co-statements and co-functions) that support real-world embedded system development. Interrupt service routines can be written in C and both cooperative and pre-emptive multitasking are supported.

(4) Dynamic C is supplied with many function libraries, all in source code. These libraries support real-time programming and machine level I/O and provide string and maths functions.

(5) Dynamic C can be compiled directly to memory. Functions and libraries and compiled, linked and downloaded on the fly. On a fast PC, Dynamic C can load 30,000 bytes of code in five seconds at a baud rate of 115,500 bps.

RCM2100 Series Ethernet Core Modules				
Feature	**RCM2100**	**RCM2110**	**RCM2120**	**RCM2130**
Microprocessor	Rabbit 2000™ running at 22.1MHz			
SRAM	512K x 8	128K x 8	512K x 8	128K x 8
Flash Memory	512K x 8	256K x 8	512K x 8	256K x 8
Ethernet Port	10Base-T, RJ-45, 2 LEDs		None	
General Purpose I/O	34 parallel I/O lines (grouped in five 8-bit ports and shared with serial ports) 20 configurable I/O 8 fixed inputs 6 fixed outputs		40 parallel I/O lines (grouped in five 8-bit ports and shared with serial ports) 26 configurable I/O 8 fixed inputs 6 fixed outputs	
Additional Inputs	2 Startup Mode, Reset In			
Additional Outputs	Status, Clock, Watchdog Out, Reset Out			
Memory I/O	13 buffered address lines, 8 buffered data lines, plus I/O Read-Write and Buffer Enable			
Serial Ports	4 CMOS-compatible serial ports Maximum asynchronous baud rate: 345,600 bps Maximum synchronous baud rate: 138,240 bps Two ports configurable as clocked ports			
Slave Interface	Slave port permits use as master or as intelligent peripheral with Rabbit-based or other master controller.			
Timers	Five 8-bit timers and one 10-bit timer with two match registers (5 timers cascadable in pairs).			
Date/Time Clock	Yes (date/hour/minute/second)			
Watchdog/Supervisor	Yes			
Backup Battery	Backup battery circuitry and connection for user-supplied battery			
Supply Voltage & Current	4.75–5.25V DC; 140mA @ 5V DC			

the registers, effectively enlarging the register set. Other new instructions provide 16-bit logical and arithmetic operations. Software floating point routines for add, subtract and multiply require less than 12µs at maximum clock speed.

An interesting feature is that memory access instructions can be turned into I/O access instructions by using a prefix. As a result, I/O access is faster and more flexible than on the Z180.

Battery backup

The Rabbit 2000 has a special support feature for battery-backed RAM.

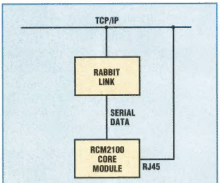


Fig.1: the Rabbit Link interface module lets you program the RCM2100 Core Module directly via a LAN or via the Internet.

At the same time, a hardware memory write-protect feature protects battery-backed RAM and flash memory from inadvertent write operations.

On-chip peripherals

There are more on-chip peripherals on this Rabbit than fleas on its furry namesake. The accompanying panel shows you what's there but we'll list them anyway. There's a slave interface which allows the Rabbit 2000 to be treated as an intelligent peripheral device; remote bootstrap (so that it can be remotely cold-booted via a serial or parallel slave port); four serial ports plus 40 I/O pins grouped as five 8-bit ports; a low-power "sleep" mode for battery-powered applications; an on-board oscillator based on a standard 32.768kHz crystal; and six timers (four 8-bit and two 10-bit, as mentioned previously).

Up to six static memory ICs can be hung off the Rabbit via those 40 I/O lines, without the need for interfacing logic.

Take a look at the accompanying panel if you want more information on these on-chip peripherals.

Rabbit on Ethernet

OK, now that we've looked at the

Programming Point-to Point Protocol (PPP)

If you want an embedded system to use the Internet for communications, PPP (Point-to-Point Protocol) is required. Included as an extension to the stand Rabbit 2000 TCP/IP stack, PPP provides the connection to an Internet Service Provider (ISP). The PPP source code is included in Dynamic C Premier (an extra-cost upgrade from Dynamic C SE).

One of the most common uses of PPP is the transfer of IP packets between a remote host and an ISP over a modem connection. The interface between the Rabbit 2000 controller and the modem is either a true RS232 interface or a variation on RS232 that uses TTL voltage levels for the signals.

The Rabbit implementation for PPP uses serial port C on the Rabbit chip. Hardware flow control is implemented and follows the RS-232 convention of using the RTS and CTS lines.

The Rabbit's On-Chip Peripherals

Slave interface: the slave port allows the Rabbit 2000 to be treated as an intelligent peripheral device. The slave port has six I/O registers, three of each direction. Handshaking flags and mutual interrupt capability are supported.

Remote bootstrap: the Rabbit 2000 may be remotely booted by an external device via a serial port or slave port with no pre-existing program. This allows complete re-programming of soldered-in flash memory. It also allows RAM-only configurations with external boot and program initialisation.

I/O interface and ports: there are 40-plus I/O pins grouped in five 8-bit ports. Eight external programmable I/O interface signals can be configured as I/O chip selects, I/O write strobes, I/O read strobes and I/O read/write strobes. Standard I/O read and I/O write enable signals are also available. I/O devices can be directly connected to the I/O interfaces, and often without glue logic.

Four asynchronous serial ports are on-chip. Two of the ports also have synchronous communication capability. The asynchronous ports operate at speeds up to 1/32 of the clock frequency, while synchronous mode allows baud rates up to 1/8th of the clock frequency.

Low power sleepy mode: a unique sleepy mode of operation is available on the Rabbit 2000. Normally, the main oscillator is implemented by directly connecting a crystal or ceramic resonator with a frequency in the range of 1.8-30MHz. The frequency can be double of divided by eight internally to modulate power consumption and speed of execution. In sleepy mode, the main oscillator is turned off and the main clock is taken from the Rabbit's 32.768kHz oscillator. Roughly 3000 instructions per second can be executed with a current consumption of around 200μA. The sleepy mode is far more flexible than sleep modes of other microprocessors because instruction execution and decision making capability are maintained. This feature is excellent for many battery-powered applications.

Clock speed: the Rabbit 2000 performs 1-byte reads (and most 1-byte operations) in two clock cycles, and 1-byte writes in three clock cycles. It requires 55ns memory to operate at 30MHz with no wait states. The Rabbit 2000 runs at 24MHz with 70ns flash memory and no wait states.

Time/date oscillator: the 32.678kHz oscillator uses an external quartz crystal. This 32.768kHz clock is used to drive a battery-backable internal 48-bit counter or real-time clock.

Timers: the Rabbit 2000 has two sets of timers, as well as a general purpose clock interrupt. The periodic interrupt is driven by the 32.768kHz oscillator divided by 16, giving an interrupt every 488 microseconds if enabled.

Timer A consists of five 8-bit reloadable down counters. The output of flour of the timers is used to provide baud clocks for the serial ports. These timers can also cause interrupts and clock the timer synchronized parallel output ports.

Timer B consists of a 10-bit free running counter and contains two 10-bit match registers. The timer generates an output pulse whenever the counter reaches the match value. This output pulse can be programmed to generate an interrupt.

Rabbit's innards, let's take a look at the RCM 2100/2200 Ethernet Core Modules and the development kits.

Ethernet? – you bet your furry ears. You can plug a RabbitCore module directly into a standard computer network and "talk" to it via your LAN. Alternatively, you can connect it directly to your PC's network card using a crossover cable. You can even program the Rabbit via a LAN, using the RabbitLink interface card (Fig.1).

So how do they get it to talk to a network? Simple – by incorporating a Realtek RTL8019AS Ethernet IC directly onto the module. This NE2000-

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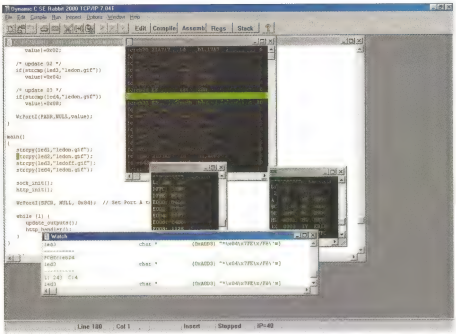


Fig.2: the Dynamic C development environment. Shown here are the main editing window, the assembly code window, the register window, the stack window and the watch window (which lets you watch variables).

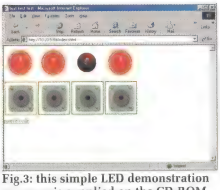


Fig.3: this simple LED demonstration program is supplied on the CD-ROM.

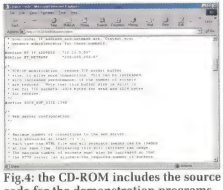


Fig.4: the CD-ROM includes the source code for the demonstration programs.

compatible chip has all the hardware "smarts" necessary for network communication and is interfaced to an RJ-45 socket that accepts a standard Cat.5 network cable connector.

That means that your RabbitCore module doesn't even have to be connected directly to your PC in order to talk to it. Instead, it can be anywhere on the local LAN or even "somewhere out there" on the Internet.

Web server

It's got other advantages as well. The software CD-ROM included with the core module includes a complete TCP/IP stack (including source code) plus a web server that can be compiled in Dynamic C and downloaded to the Rabbit's flash memory.

Yes, that's right – you can build an embedded web page server or an SMTP email server right into this unit. Think of what you could do with that for industrial process control and monitoring applications.

The core module can also be mounted on a user-designed motherboard and can act either as the controlling microprocessor or as a satellite processor to relay network communications. A satellite processor allows remote monitoring of system operation and allows any faults to be remotely corrected.

It can also serve as a portal for downloading updated software to the main system.

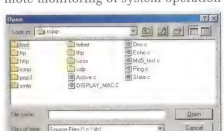


Fig.5: source files for the various networking protocols are on the CD-ROM.

Developer's kits

There are five developer's kits available for the Rabbit; (1) Rabbit 2000 TCP/IP Developer's Kit; (2) RabbitCore RCM2000 Developer's Kit; (3) RabbitCore RCM2100 Developer's Kit; (4) RabbitCore RCM 2200 Developer's Kit; and (5) the RabbitCore RCM2300 Development Kit.

The developer's kit pictured in this article is the RabbitCore RCM2100. It's supplied with the following items:

(1). The RCM2100 Ethernet core module with 512KB of flash memory and 512KB of static RAM;

(2). A prototyping board complete with power supply circuitry, LEDs, switches and prototyping area;

(3). An RS232 programming cable (10-pin header to DB9);

(4). Dynamic C SE CD-ROM – includes royalty-free TCP/IP stack with source plus product documentation;

(5). A plugpack power supply; and

(6). A "Getting Started Manual".

The "Getting Started Manual" is quite comprehensive and details the hardware setup and the Dynamic C software installation. It also includes several sample Dynamic C programs with full instructions on how to compile and run these, so that you can quickly familiarise yourself with the RabbitCore module.

The manual concludes with full circuit diagrams of the RabbitCore RCM-2100 module and the RCM2100 prototyping board.

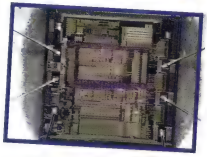
Catching your Rabbit

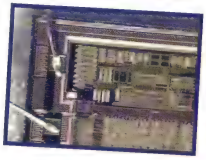
You can catch your very own silicon Rabbit at Dominion Electronics, Suite 201, 82 Christie St, St Leonards 2065. Phone (02) 9906 6988 or email sales@dominion.net.au

The RCM 2100 Ethernet Core Module costs $223.00, while the lower-specced RCM2200 retails for $126.00. The development kits, which include the core modules, cost $682 and $580 respectively. The Rabbit 2000 Basic Development Kit is $379.50, while the Rabbit 2000 TCP/IP Development Kit is $489.50.

For more information on what's in the Rabbit burrow, point your browser to **www.dominion.net.au** **SC**

Ever wanted to view something *really* close up – far beyond the capabilities of your eyes? Or perhaps you need to show that extreme close-up to several people at once; maybe even save an image to a disk? This easy-to-build Videoscope – a combination Video Camera and Microscope – will do all this and more!





videoSCope

Design by Peter Rosenthal
Words by Peter Rosenthal
and Ross Tester

A number of years ago, SILICON CHIP featured a story about an industrial microscope with an inbuilt camera, capable of displaying images on a monitor. It sold for about twenty thousand dollars or so.

And just as we were preparing this article for publication, a press release arrived featuring a similar device from Sony – selling for not much less (see separate panel).

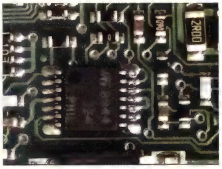
Well, this VideoSCope will do a similar sort of job – perhaps not with quite the same finesse as the Sony but similar nevertheless. And even if you have to buy all the bits to make it (unlikely!), you should spend no more than a couple of hundred dollars. Some people may well have most, if not all, of the components gathering dust, just waiting for a use.

"So that's what I can do with that old SLR camera lens I knew was too good to throw away . . ."

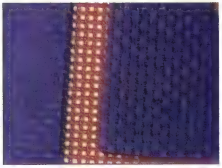
In fact, this project grew from a Sunday afternoon pulling apart some old scanners, wondering what the lenses could be used for. It has grown into one of the most indispensable workshop instruments.

What will it do?

Just about anything that you can do with a conventional microscope, you can do with the VideoSCope – and then some! There are a few limitations which we'll look at later but suffice to say, you will find so many things to do with it – as I have – you'll wonder how you got along without it.



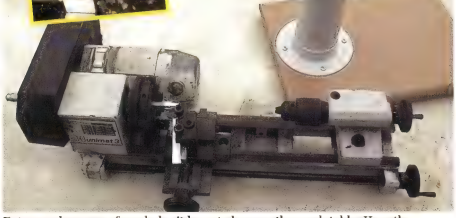
It's great for checking soldering defects, especially on SMD boards! This shot is at low magnification.



A screen-printing stencil, magnified about 3200 times, taken with a web camera instead of the video camera.

Here are just a few examples: examining solder joints on PC boards – even surface mount devices (SMDs). Looking for cracks or defects in automotive and other engineering parts. Student projects – examining leaf structures, water, blood, and so on. Even enlarging resistors so their colour codes are immediately obvious to tired old eyes!

Another use I have put this to is attaching to machine tools for doing fine work like PC board drilling, fretsaws, and lathe work as in the photo below.



Extreme close-ups of work don't have to be over the work table. Here the videoscope is swung through 180° to look at the business end of a lathe. Inset is what the camera saw – much finer detail than you could hope to see even with 20/20 vision. This is not a particularly high magnification pic and is somewhat over-exposed – but you get the idea!

I recently had to take a photo of a screen printing stencil and fabric for work and just by rearranging the pipe fittings I was able to gain an effective magnification of 3200 using a 640 x 480 web camera and a standard camera lens.

With today's miniaturisation of circuitry, the VideoSCope is also ideal for circuit inspection and servicing. Included are some pics of ICs taken with this device so you can see the detail and enlargement possible.

The photos on the opening page of this article show inside an IC. Not bad, eh?

All of the components required are readily available. As we said before, some you may already have.

The two items you may not have are the CCD camera module itself and a suitable lens. The camera module can be black and white or colour; any type will do, depending on your possible uses. Colour is nice but obviously more expensive.

This design is based on Jaycar's QC 3483 (thanks to Jaycar for lending me the camera!). One advantage of this camera is that its lens is easily removed and it also comes with a small mounting bracket. You may have another camera on hand or in mind – as long as it fits the space, it has a mounting bracket and its lens is removable, it should be suitable.

Alternatively, a web cam would be handy if you want to save and print photos. You simply change a length of pipe to adjust the magnification to suit. Of course, the video camera could also be used for the same purpose in conjunction with a suitable video capture card in your PC.

As far as the lens is concerned, almost any lens out of a fax machine, photocopier, scanner, etc could be used but I found the best results from

Lo-magnification mode (above) with the lens and camera both mounted on the underside of the "T" piece; and hi-mag mode (right), with the lens and camera mounted on opposite sides of the "T" piece. Changing modes is very simple.

an SLR lens from an old 35mm camera. It has the advantage of adjustable focus and aperture, which most lenses do not.

A few plumbing bits are needed – some may be already in your junk box (plumber's variety!), others you might need to scrounge from a friendly plumber or – perish the thought – buy from a plumber's supply or hardware store. There is nothing which should cause you any great problems, though.

How it works

Basically, we are using the camera lens to project an image of the object that we are looking at onto the surface of the CCD element inside the camera. By increasing the distance between the lens and CCD and reducing the distance from the object to the lens, we increase the power of magnification.

The camera is a "plumber's special", based on 50mm PVC pipe. We can change the distance between lens and CCD by changing the lengths of pipe.

We don't want to make this a treatise on photographics and optics but a couple of salient points might make understanding a little easier.

Adjusting the focus of the lens is self-explanatory – we want to achieve the sharpest possible image on the surface of the CCD element. Most low-cost video cameras do not have easily adjustable focus; using a 35mm camera lens allows this adjustment. In fact, in the VideoSCope, the focus on the lens is actually a "fine focus" adjustment. Coarse focusing is achieved by physically changing the distance from lens to CCD element.

Aperture is something that is less well understood. The aperture control adjusts an "iris", a series of vanes inside the lens which progressively allows more or less light to pass through the lens. At its maximum (the lowest "*f*" stop of the lens – a number such as f1.4 or f1.8 is common) the iris is effectively not there – the lens is said to be "wide open". Conversely, when you adjust the lens to its minimum (the highest "*f*" stop – a number such as *f*16 or *f*22) the iris is closed to a very small opening – in some lenses, just a pinhole. The lens is said to be "stopped down".

Each *f*-stop on a lens allows half (or double) the light in of the previous stop. Therefore changing a lens from *f*8 to *f*16 (two stops) allows just a quarter of the light through.

While it might seem that we need to allow as much light through the lens as is available, this is not so. When you adjust the aperture to "wide open", you minimise the depth of field, that is, the range of distances from the lens which will be in focus.

By going the other way and "stopping down" the lens as far as possible, you maximise the depth of field. But as we mentioned, this dramatically limits the amount of light passing through the lens and therefore striking the CCD elements.

Most of the time, taking a picture (video or still) is a compromise between the two: depth of field and exposure. If you can increase the amount of light (eg, by illuminating the subject better) you can go for a higher "*f*" stop and achieve a better depth of field. That's also what a flash does.

On an ordinary camera, increasing the time the shutter is open has the same effect – more time equals more light – but you reach the point where movement (either camera or subject) starts coming into play. On the VideoSCope, there is no shutter.

If you are looking at a single-plane object and/or the magnification isn't too dramatic, depth of field matters less than if you are looking at a 3-D object. Unfortunately, photocopier and scanner lenses are specifically designed to work in one plane and usually have no iris (aperture control) so they are wide open (minimum depth of field) all the time.

Again, that's why the 35mm SLR camera lens is a better option for this project.

How it's made

There are many ways which this project could be made and possibly

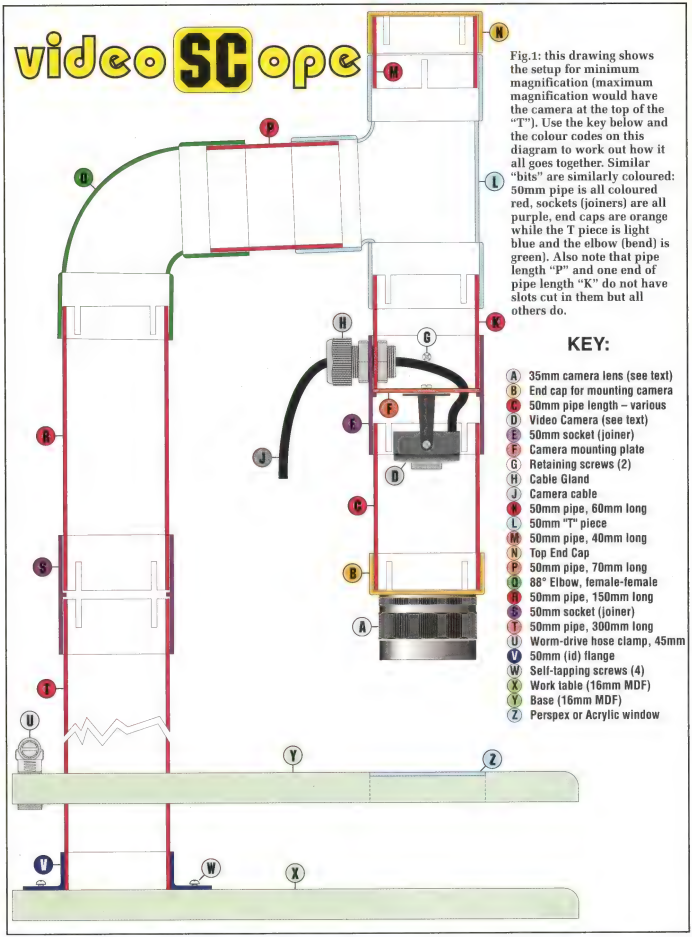
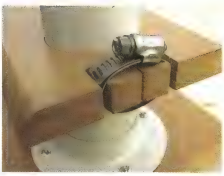


Fig.1: this drawing shows the setup for minimum magnification (maximum magnification would have the camera at the top of the "T"). Use the key below and the colour codes on this diagram to work out how it all goes together. Similar "bits" are similarly coloured: 50mm pipe is all coloured red, sockets (joiners) are all purple, end caps are orange while the T piece is light blue and the elbow (bend) is green). Also note that pipe length "P" and one end of pipe length "K" do not have slots cut in them but all others do.

KEY:

- (A) 35mm camera lens (see text)
- (B) End cap for mounting camera
- (C) 50mm pipe length – various
- (D) Video Camera (see text)
- (E) 50mm socket (joiner)
- (F) Camera mounting plate
- (G) Retaining screws (2)
- (H) Cable Gland
- (J) Camera cable
- (K) 50mm pipe, 60mm long
- (L) 50mm "T" piece
- (M) 50mm pipe, 40mm long
- (N) Top End Cap
- (P) 50mm pipe, 70mm long
- (Q) 88° Elbow, female-female
- (R) 50mm pipe, 150mm long
- (S) 50mm socket (joiner)
- (T) 50mm pipe, 300mm long
- (U) Worm-drive hose clamp, 45mm
- (V) 50mm (id) flange
- (W) Self-tapping screws (4)
- (X) Work table (16mm MDF)
- (Y) Base (16mm MDF)
- (Z) Perspex or Acrylic window

The first step is to accurately cut the circles in the MDF base and work table, then smooth them with glass paper wrapped in something round and fairly close to the finished size, as shown at right.



Here's how the hose clamp grips the "fingers" cut into the MDF, making it a nice tight (but moveable) fit on the vertical pipe. The centre cut goes all the way to the circle and only needs to be a couple of millimetres

made smaller but given the fact that we want to fit both a 35mm camera lens and a miniature camera, the "plumber's special" approach using 50mm PVC pipe seems logical. It's also relatively cheap, easily obtainable (if you have to buy it) and the material is easy to work with.

Another big advantage of this method of construction is that a huge range of focal distances can be obtained, simply by changing pipe lengths.

The prototype is shown in the photographs and in Fig.1. We'll start with the "business end" first, the lens and camera assembly.

The lens is mounted on a 50mm end cap. Exact method of mounting depends on the type/brand of lens you use – we cut a hole just large enough to fit the threaded lens through (a friction fit) and then used some double-sided adhesive to make sure it stayed where we put it.

The end cap fits into one of the several lengths of pipe we cut to allow easy changes to the lens-to-CCD-element-distance. We cut 60, 70 and 75mm lengths to swap as required.

Camera mounting

The camera in question (Jaycar QC 3483) is delightfully simple to mount. It comes with a U-shaped bracket which is secured to a disc of Perspex (or similar) cut to 55mm – just less than the inside diameter of the 50mm pipe joiner (in plumbing parlance properly referred to as a socket).

Inside the socket, half way along, is a ridge. When using the socket normally (ie, joining two pipes) this ridge stops the pipes in the right place. Our disc sits on this ridge, with a short length of 50mm pipe slid down onto it to hold it in place.

This length of pipe has a cutout to accommodate the power/output wiring from the camera, while the socket itself has a suitable-size hole for the cable gland. We'll come back to this shortly.

The stand

Referring again to Fig.1, there is a 300 x 200mm baseboard made from 16mm MDF. Fitted to this is a 50mm flange into which a 300mm length of 50mm PVC pipe is inserted.

Slid over this pipe is the work table, a slightly smaller (300 x 150mm) piece of 16mm MDF. A Utilux (worm-drive) clamp at one end tightens fingers cut

All of the components of the VideoSCope, including spare lengths to change magnification. Cut out the various lengths of pipe as listed in the parts list. Make sure their ends are nice and parallel and smooth, with four slots cut in most of them to allow easy movement.

The camera mounts on a disc of solid material such as Perspex, cut to exactly 55mm diameter so it sits on a ridge inside a 50mm socket (joiner). If those dimensions sound wrong, they're not: a 50mm socket actually has a 56mm internal diameter! Incidentally, it doesn't have to be clear, as this one is.

into the MDF so it can grip the pipe.

The work table has a cut-out window in one end fitted with a piece of clear Perspex or similar material. The reason for the window is so you can illuminate an object from underneath. It could be considered optional but underside illumination is a feature of most "normal" microscopes. (Indeed, it is essential for many observations).

On top of the 300mm pipe is a 50mm socket with another length (this time 150mm) of PVC pipe. On top of that pipe is a right-angle elbow or bend, so now the pipe is horizontal.

Well, it's close to 90°. That's 'cos there is no such thing as a right-angle elbow. They're actually made at 87°. So in fact our pipe ends up a few degrees off horizontal (three, to be precise!).

Fitted to this elbow is another 70mm length of pipe, which in turn fits into the leg of a 50mm "T" piece. Once again, you will note that "T"s are not 90° – the leg is actually at 88°. What this means is that if you fit the "T" the right way around, they nearly cancel each other out and you are left with only one degree of error. Turn it up the other way and the error becomes five degrees – a tad too much!

It is the "T" piece that the lens/camera assembly attaches to. What you should end up with is the lens pointing near enough to straight down to the Perspex window in the work table.

You may wonder why we use a "T" instead of an elbow. There are two reasons: one is that two elbows would end up with six degrees of error. While that might be acceptable in some circumstances, it wouldn't in others.

The second reason is even more important: the "T" allows maximum flexibility in lens-to-ccd-element distance. If you want maximum magnification, you want maximum distance: the lens can be fitted under the T while the camera assembly can be fitted above it (obviously with the short bit of pipe and end cap removed first!).

None of the joins between the pipes, sockets, elbows and Ts are glued because we need to be able to make changes as required (eg, to adjust magnification or aim the camera elsewhere).

Normally, these pipe fittings are a tight friction fit; once in they stay in and removing them takes much effort! To help make them slide in and out of each other easily, each of the pipe lengths has four 15mm slots cut into them, about 2-3mm wide. These are shown in the photos and in Fig.1.

Construction

Start by cutting out the 16 mm MDF baseboard and work table, taking care with accuracy of the 56mm holes. The hole in the baseboard needs to be a tight fit while the hole in the work table needs to allow the table to slide up and down the pipe. It's not a loose fit, just comfortable! Get this hole right before cutting the slots, as shown in Fig.2, drawing 3.

If you use a jigsaw to cut holes, a narrow scroll saw blade will be required because of the tight radius. Cut slightly under size by following inside of the line, then sand to size by using a piece of sandpaper wrapped around something round. The closer

The video camera assembly mounted in its holder, shown from below (below) and above (right). Note how the mounting plate sits on the ridge inside the pipe socket (joiner). You can also see how the camera cable comes through the mounting plate and out through a cable gland. Above right is the 60mm length of pipe which clamps the mounting plate (and camera) in position, inside the socket. Note the cut-out to clear the cable gland.

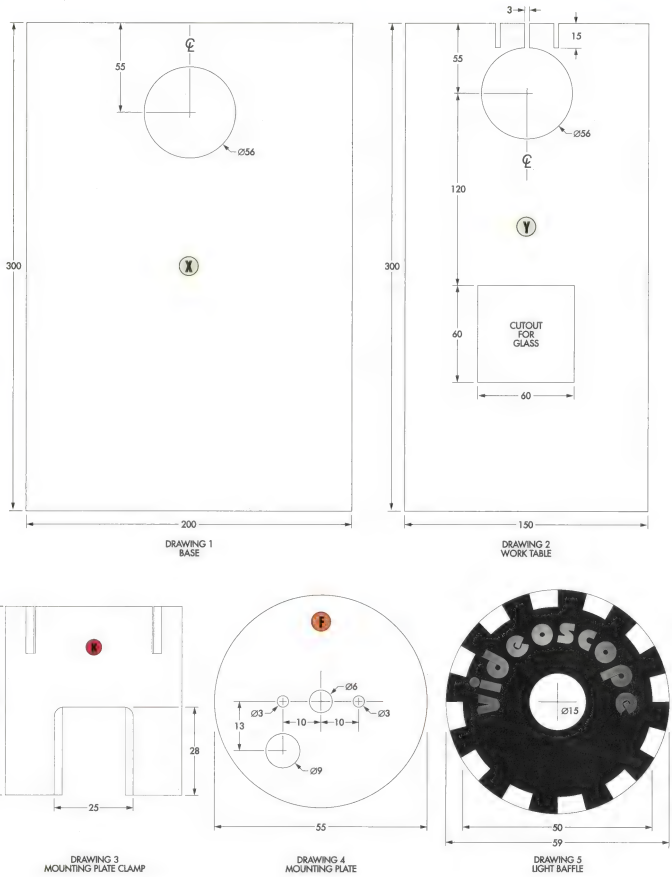
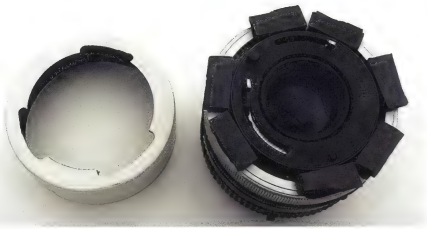


Fig. 2: drawings for the various components used in the VideoSCope. Drawing 4 and drawing 5 are same size; rest are to scale. Drawings 1 & 2 use 16mm MDF, 3 uses 50mm pipe, 4 any stiff material to about 3mm thick and 5 can be thin cardboard.



Here is the lens-mounting end cap with the cut-out to suit the particular lens we used. On the right of this pic is the lens itself with adhesive foam tabs stuck in place ready to mount on the cap.

And here's what it looks like stuck on. We trimmed the edges of those tabs with a sharp knife.

this is to 56mm, the better.

If you do not have a jigsaw you will need to drill a series of holes inside the circle circumference, cut out the remaining material then file and sand to size. If you need some practice, use a scrap of timber first!

The square cutout in the table is optional – it only needs to be added if you wish to view transparent objects by backlighting them. This is filled with a piece of transparent perspex, acrylic or even glass.

Pipework

First, the camera mount: drill a 16mm hole in the side of one of the sockets (the pipe joiners) 15mm down from the top. Insert the cable gland. Next, cut a 60mm length of pipe with a cutout as shown in Fig.2 drawing 4. Check that this cutout clears the nut on the cable gland in the socket. Two screws can used to hold this part in place.

Cut out the 50mm disc which will be the camera mounting. We used a scrap of Perspex but it can be any rigid material up to about 3mm thick. We drilled one single camera mounting hole right in the middle of the disc; other holes might be needed to suit the bracket supplied with your particular camera.

A suitable hole is also drilled through the disc for the cables to pass through. Ours was a lot wider than broad because the cables from this particular camera are triple-width.

The camera needs to be mounted square and centrally on this disc, which then fits flush on the ridge inside the socket. For the time being, leave the lens fitted to the camera in place – it protects the CCD element inside.

The baffles (as shown in Fig.2, drawing 5) are used to minimise internal reflection in the pipe. When set up for large magnification, the picture may be cloudy and washed out. The baffles prevent this happening.They are made from stiff paper or light card. Around the edge of baffle, cut the tabs as shown in the drawing and fold each tab in opposite directions.

Cut the pipe to the lengths nominated in the parts list and clean up the cut edges. Cut the four 3mm wide x 15mm long slots in it at 90° spacing. As previously mentioned, this is to allow easy insertion and, more importantly, removal.

Parts List – VideoSCope

1 35mm SLR lens
1 CCD camera module (Jaycar QC 3483 or equivalent) with regulated 12VDC power supply to suit
1 50mm pipe 300mm long with four 15mm x 3mm slots cut both ends
1 50mm pipe 150mm long with four 15mm x 3mm slots cut both ends
1 50mm pipe 90mm long with four 15mm x 3mm slots cut both ends
1 50mm pipe 75mm long with four 15mm x 3mm slots cut both ends
1 50mm pipe 70mm long with four 15mm x 3mm slots cut both ends
1 50mm pipe 70mm long – no slots
1 50mm pipe 60mm long with four 15mm x 3mm slots cut both ends
1 50mm pipe 60mm long with four 15mm x 3mm slots cut one end and cutout to clear cable gland (see drawing 3)
1 50mm pipe 40mm long with four 15mm x 3mm slots cut both ends
2 50mm DWV end caps
1 50mm DWV flange
1 50mm DWV 88° tee piece
1 50mm DWV 87° elbow
2 50mm DWV socket (pipe joiner)
1 55mm diameter x up to 3mm deep camera mounting plate
1 60mm x 60mm (approximately) Perspex or Acrylic work table window
1 300mm x 200mm x 16mm MDF baseboard
1 200mm x 150mm x 16mm MDF work table
4 rubber feet
1 42mm worm-drive hose clamp
1 12mm cable gland
6 6g 12mm self-tapping screws
1 5mm screw & nut or 2 3mm screws & nuts (to mount camera)
Thin card to make two 60mm discs (for baffles)
Double sided adhesive tape, pads etc or silicone sealant (to mount lens)

Another view of the lens assembly, looking at the back of the lens. The pin you can see stops the lens down as a shutter fires; you might need to fix this in position on some lenses.

Even with these slots, the pipes should be a firm (friction) fit in the sockets, elbows and T piece.

While PVC pipe is quite easy to cut with virtually any saw, an angle grinder fitted with a thin blade makes it even easier. It's also very handy for trueing the end cuts and cutting the slots, too.

Painting

All internal parts of the pipework, including joiners, T-piece, etc which might be used in the light path between lens and camera need to be painted matt black to stop light reflections. DO NOT paint the fittings (ie, sockets/T/elbows) where the pipes slip in and out – this might make the pipes bind.

The baffles also need to be painted, while the wooden base and work table can be sanded and varnished.

Mounting the lens

The camera lens is mounted in a hole cut in an end-cap, which itself slips over the end of a length of pipe.

The idea of this project is to use a lens which is not going to be used on a camera again, so gluing it it place won't cause any future problems!

Because of the differences in various camera lenses, you will have to cut the end cap to suit your own. You only need to cut a hole in the centre as large as the part of the lens that fitted in to the camera.

If you use a screw-thread lens (Pentax, etc), if you are very careful with the size of the hole in the end-cap you may be able to use the screw-thread as a self-tapping screw, holding onto the PVC. But some form of adhesive may still be required.

I used double-sided tape to mount the lens, making sure to get a good bond by cleaning both surfaces. Also make sure there is nowhere for light to get in by wrapping the assembly in black vinyl tape.

Another alternative would be to use some silicone sealant as a glue and again lightproof it with black tape.

Notes on aperture adjustment

Some lenses are fully automatic and only stop down to the set aperture when the picture is taken. Others are semi automatic (with an auto/manual switch) or fully manual. If you have an automatic lens, you will need to work out a way to hold down the lever or pin which stops the iris down. This is important as the auto iris of the camera often wants to set it self too dark or to light.

Assembly

Insert any piece of pipe through the hole in the baseplate, slide the flange over the pipe and mark the position of the four screws which hold the flange in place. Screw the flange onto the baseboard.

Attach four rubber feet in the corners of the underside of the baseboard. If required, cut and glue your piece of Perspex or acrylic into the "window" cut in the work table. Undo the hose clamp completely and place it in position on the slots in the work table.

IMPORTANT

Before you go any further, clean your work area and the pipe assembles thoroughly for dust and debris – especially the fine dust created when sanding or cutting the PVC pipe. Once you have removed the lens there will be nothing to protect the CCD from collecting dust.

Do not touch the surface of the CCD, as removing fingerprints will be difficult, if not impossible. I cannot stress this enough – a microscopic piece of dust will show as a great black spot on your screen.

If you do need to clean the CCD, I suggest using a proper lint free lens cleaning cloth. When the viewing aid is not in use make sure you keep the camera section sealed by leaving the lens and end cap on to keep dust out.

The baffle(s) mount inside the pipe between the lens and CCD camera and help prevent light reflections from washing out" the captured image. They can be made from any stiff material (cardboard, etc) and are painted black both sides.

Fig.1 shows the general arrangement for viewing at minimum magnification. Insert the longest piece of pipe in base, place an elbow on top, add a 65mm length of pipe (horizontal) and add the "T" piece as per drawing.

Mounting the CCD camera

Unplug the three connecting cables from the camera – most have a tiny plug and socket on them. Remove the two screws which hold the camera to its U-shaped mounting bracket and then secure this bracket to the camera plate (disc).

Now replace the camera on the bracket (with the two screws) and place the camera plate assembly into the opposite end of the socket to the hole for the cable gland. Ensure the assembly sits down on the internal ridge.

Take it out again for the moment and pass the camera cables through the undone cable gland, then up through the hole in the camera plate and re-connect them to the camera itself. Slide the camera plate assembly back down into the socket, pulling the cable back through the gland as you do. Tighten the gland nut firmly to lock in place.

The camera top should be just proud of the top of the socket, allowing you access to the tiny grub screw which keeps the lens in position.You will probably need to remove this grub screw using a jeweller's screwdriver before screwing the lens off the camera. This lens is not required again.

Testing

Most of these small cameras require a regulated 12V supply – in fact, you

And if you have an idle $12,000 . . .

OK, we admit it. This TechnoLOOK video microscope from Sony does look a bit more stylish than ours. Not a bit of PVC pipe to be seen!

But then again, for around twelve big ones, it would want to look good. Aimed at the high-end education and industrial market, the TechnoLOOK sports a 17cm TFT LCD screen and a magnification of up to 40x.

Weighing in at a fairly hefty 6kg, the TechnoLOOK sports a 410,000 pixel CCD and along with its inbuilt LCD, outputs a PAL signal for displaying on an external monitor (video or S-video). Images can be sent from TechnoLOOK to a PC for editing, emailing or incorporation into presentations, magnified to a large-screen display for training, or output as hard copy via a printer.

There is a 10x manual zoom; focus and iris adjustment are also fully manual. Zoom, focus, brightness and camera head position are adjusted using four simple controls.

The unit has an inbuilt laser pointer for positional adjustment and an inbuilt fluorescent lamp provides illumination. For more information, visit the Sony website at: www.sony-cp.com/microscope

will void the warranty if you use anything but on some, including the one we used from Jaycar. Connect the supply and connect the video output from the camera to a suitable monitor.

Swing the table out of the way and set the focus to about halfway with the aperture wide open (ie, lowest "*f*" stop). Take an object with plenty of detail and, starting from the base board, move it up towards the lens. You should see it come into focus at some point. Set the table at this height and use the focus ring on the lens to fine focus. You may also need to adjust the aperture for best picture.

Higher magnification

To increase magnification, simply add more distance between camera and lens by changing pipe lengths. For maximum distance, connect the lens to the bottom of the "T" piece and the camera assembly to the top.

Lighting

Ambient lighting should be enough for general use. However, if you are trying to take photos you may need to change the colour of the light source to suit as some CCD cameras highlight certain light frequencies: fluorescent will bring out blues and incandescent the yellow/red shades.

The window in the table is for rear lighting of transparent objects. A piece of paper placed on the base is effective in reflecting light upwards.

The closer you get the object to the lens the harder it is to get light in. Also, higher magnification requires more light. If possible, illuminate the spot you are looking at as the excess light can be projected onto the side of the pipe and reflected up to the CCD.

The baffles minimise this problem. Insert one at approximately 60 mm up from the lens and one 60 mm down from the camera.

Guide

Using a 55mm lens with 40mm between the bottom of the joiner and lens mount, the focus range should be about 24cm to 70cm. A 55mm distance will give you a focus range of about 17cm to 24cm.

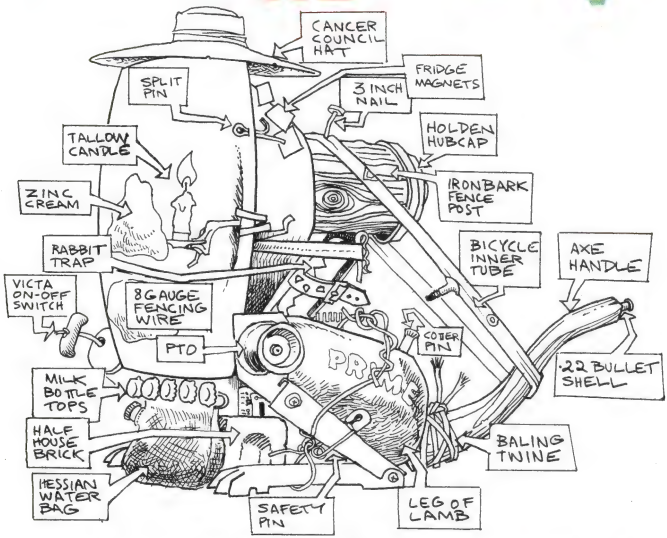
Remember you can change lengths by swapping pipes or moving the camera above the "T". This will dramatically change the focus ranges. Experimentation is the best policy.

Web cameras

Most web cams are too big to fit inside 50mm pipe. Instead, try mounting it in a zippy box.

To make it compatible with this system, you will need to attach the zippy box to a length of 50mm pipe with a hole through the box. When you fit the camera in the box, make sure that its CCD element is in the centre of the pipe and is mounted horizontally. **SC**

SILICON CHIP : AS AS



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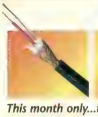

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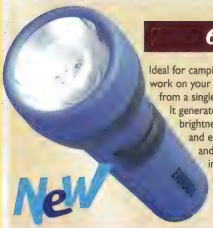

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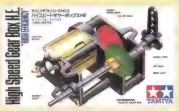

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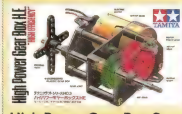

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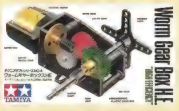

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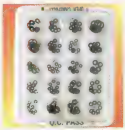

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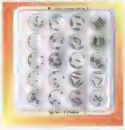

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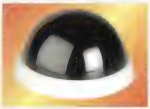
L 5852

$69.94

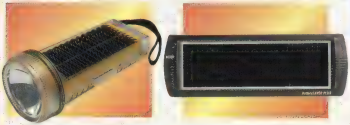


Dummy Dome Camera

Imitation security camera ideal for small shops as a theft deterrent. Easily installed, just screws onto ceiling. Uses a real camera housing so it looks realistic.

L 5854

$29.80



Weather-Proof Solar Torch

This water-resistant torch has a nylon carry strap and a flashing LED which is useful as a warning light. The bicycle mounting kit makes it easy for the torch to be used as a headlight.

D 2045

$19.60 SAVE $5

ICP Solar Panel Plus 1.8W

Maintains charge on 12V batteries. Ensures quick starts and extended battery life. Connects through cigarette lighter socket or direct to battery. Blocking diode prevents reverse current at night. Power rating: 1.8W (125mA @ 15V).

D 3300

$49 SAVE $10

ICP SOLAR TECHNOLOGY

Heavy Duty Portasol Kit

The PSI-100K is a rugged, professional-use butane-powered soldering iron complete with a range of tips, all packed in a solid plastic case. Applications include soldering, heatshrinking and rope cutting. Features include a large butane reservoir allowing up to two hours operating time, as well as an auto switch safety shut-off, heavy-duty iron-plated tips and an in-built fuel filter.

T 1358

$135 SAVE $24

Weller/portasol

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DICK SMITH ELECTRONICS *That's where you go!*

Build your own

MP3 Jukebox

Part 2:
By PETER SMITH

Play all your favourite music by remote control

In last month's issue, we described the hardware part of our MP3 Player. This month, we show you how to program the microcontroller. And because we'd hate to you keep you in suspense, below you'll find details on how to install and set up the software that links the hardware to Winamp, our chosen MP3 music player.

AFTER READING our articles on the MP3 music format last month, you've probably converted all your CDs to this convenient, space-efficient format, stored carefully away on that new big-GB hard drive ready for the Jukebox – right?

So let's find out how to put them to use!

The basic idea behind this project is to enable you to control an MP3 music player (Winamp) running on a Windows PC with a standard infrared remote. Up until now, you've probably only ever listened to your MP3s while sitting in front of your computer. But imagine for a moment that your PC is actually a jukebox and that you can control it from anywhere in the room just like you do right now with your stereo system!

In keeping with the jukebox theme, we've included features like track shuffle and repeat, multiple playlist support and a liquid crystal display for vital track information. And if you're a budding DJ, Winamp can be set up for track cross-fading and other great effects – but more on that later.

The IR Remote Receiver & LCD hardware described last month mounts up front in an empty 5¼-inch drive bay in your PC's case. As it attaches to one of the snap-in drive blanking plates, no modifications to your PC case are required. If you want to remove it at some time in the future, all you need is a spare blanking plate.

With only two plug-in connections, hooking up the hardware couldn't be easier. Power is sourced directly from the PC's power supply via a disk drive connector and serial data is exchanged via a free serial port. To keep the serial cable hidden, it is routed through the case internals, exiting via any unused expansion slot hole at the rear. It then plugs into one of the standard 9-pin serial port connectors.

On the software side, you need a copy of our "IR Remote Control for Winamp" program, which we describe in detail below, as well as the current version of Winamp.

PC requirements

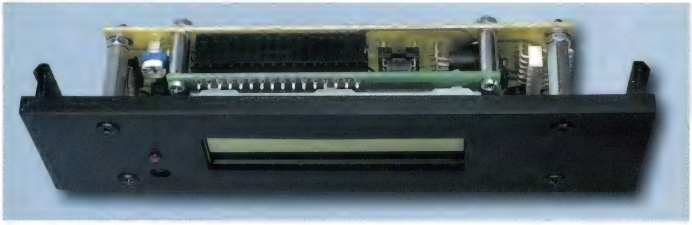
The minimum PC hardware specifications we recommend are a P133 processor (or equivalent) with 32MB of RAM. To do audio track ripping on the same machine, you'll need a faster processor, say about a P233, and more memory.

If you intend playing MP3s directly from CD, you'll also need a fast CD-ROM drive. We've found that "real" CD-ROM drive speed varies from model to model, so it's difficult to predict what will work OK on your machine. A drive that's not up to the job will cause short pauses during play, which can be quite annoying. Storing your MP3 files on a hard drive is the preferred option. Tracks typically consume about 3.5MB of disk space each, so start saving for a big drive if you have a large music collection!

Naturally, you'll also need a sound card and amplified speakers. For reasonable sound at a good price, check out the Logitech Soundman or Cambridge range of PC speakers or even better, hook up to your stereo system or ghetto blaster! Note that the sound card should be a PCI bus type (as most will be), not one of the old ISA bus variety. We used a SoundBlaster Live for all of our tests.

Pentium gobbler

If you've used Winamp before, then



Repeated from last month, this photo shows the IR Remote Receiver & Display unit for our MP3 Player. It clips into one of the PC's drive-bay positions, as shown in the photo on the facing page, and is connected to a spare serial port. Check out last month's issue for all the construction details.

Fig.1: MP3 files loaded into Winamp's playlist that don't include ID3 tags are listed by filename, as shown here.

Fig.2: Winamp displays the artist and track information once the tags have been created.

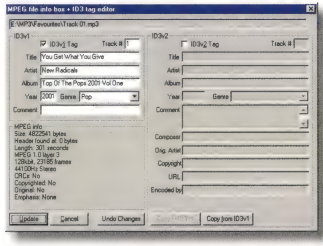


Fig.3: Winamp's ID3 tag editor. Both ID3v1 and ID3v2 formats are supported but only ID3v1 is used by the Jukebox.

you might have discovered some of the amazing visual effects (called Visualizations) that it provides. If you want to run any of these (especially in full-screen mode), then forget that old Pentium. You'll need a recent machine with a fast AGP graphics card to even get off the ground!

The Jukebox software has been tested on Windows 95, 98 and NT4. It should also run on Windows Me but we haven't tried it.

Installing Winamp

The first task is to download and install Winamp. Point your browser to **www.winamp.com** to obtain your copy. On the download page, you'll see that you have a choice of three different flavours of Winamp; "Full", "Standard" and "Lite". Any of these will work with this project but if you already have Windows Media Player installed and wish to continue using it, then you really don't need the "Full" version.

Winamp is often distributed on "shareware" CDs on magazine covers, too. Check that you have version 2.73 or later though, as older versions may not work correctly with our software.

Installing Winamp is quite straightforward. Double-click on the downloaded file to launch the installation program and follow the on-screen prompts. In most cases, the default options will be fine. Once installed, launch Winamp and verify that you can load and play a selection of your MP3 files.

We doubt that you will have too much trouble driving Winamp but if you do get stuck, Nullsoft (the creators of Winamp) have provided excellent on-line documentation and support information on their web site at **www.winamp.com**

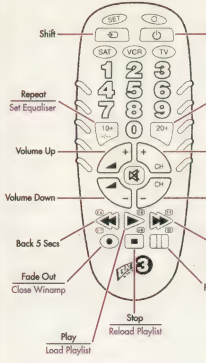


Fig.4: this diagram shows the key assignments we chose on our BC3000 remote. Functions shown in purple (below the line) are accessed by pressing the Shift key first. Unlike the Shift key on a keyboard, you don't actually hold down the Shift key to get the alternate function.

IR remote control for Winamp

The next step is to install the software that links Winamp to our IR Receiver & LCD hardware. Go to **www.siliconchip.com.au** and follow the link on the home page to the software download section. You'll find the project files for this month at the bottom of the page. All you require is the single file called "IRRemote

Control for Winamp".

Before you begin, close any applications that you have open. Next, navigate to wherever you saved the downloaded file and double-click on it to launch the installation. The first dialog box to appear prompts for an installation directory. Click the *Next* button to select the default directory unless you have a specific need to install the software elsewhere.

After a few moments, you will be asked if you want IR Remote to load at startup. Unless you are building a dedicated Jukebox, you will probably want to start IR Remote manually, so click the *No* button. Once installation is complete, reboot you PC so that Windows can update all necessary files.

Creating playlists

Before starting IR Remote for the first time, you need to create at least one playlist. A playlist is simply a text file that lists the filenames of all the MP3 files (tracks) that you wish to play. Tracks are played in the order that they appear in the list, unless you select the track shuffle option, which we'll describe a little later.

One playlist file can contain up to 199 tracks. This might sound like a limitation but it's not; the software supports multiple playlists (up to 99), expanding your listening pleasure to over 19,000 tracks!

You can create a playlist using a text editor such as Notepad but unless you only have a few MP3s, there's a much quicker way. Before we tell you about it, we'd like to make a few suggestions on how you can keep your MP3 files in order.

Order, order!

Most MP3 players allow you to dump all your MP3 files in one directory and then hit the play button. That's nice and easy but from our experience, the list soon becomes so large that you waste a lot of time searching for your favourite tracks.

We suggest creating a directory called "MP3" and inside that directory, create a new directory for each album. If you download a lot of MP3s or swap with friends, then the album idea won't work, so try storing them in directories named by time ("Today", "This Month", etc), by preference ("Hot", "Favourites", "Party") or perhaps by artist name. You get the idea?

The IR Remote Control software works with Winamp, the best freeware music player in the universe (well, that's our opinion anyway).

Having organised everything logically in this way, you then need to create a separate playlist for each directory. Most CD audio rippers allow you to create a playlist and build the ID3 tag for each file in one operation (see the article on rippers & encoders in the September issue). In addition, it's a good idea to name each file by track title for quick identification later.

ID3 tags

As you've probably already guessed from the name, ID3 tags provide identity. The first version of this tagging system, dubbed ID3v1, defines the format of a small block of data that is tacked on to the end of an MP3 file. This data contains descriptive information about its host file, such as the artist, track title, album name and so forth.

MP3s downloaded from the Internet will probably include the tags. However, when you create your own MP3s you need to generate the tags yourself. It's not mandatory that MP3 files have tags but if they don't, all you'll see when playing them is the filename rather than the all-important artist and title information.

Oops!

Last month, we forgot to tell you about the purpose of trimpot VR1 on the IR Remote Receiver & LCD PC board. It adjusts the viewing angle of the LCD module.

To set it correctly, power up the board and adjust the pot to achieve the best character contrast from your normal viewing position. Note that if the trimpot is adjusted fully clockwise, you may not see anything on the display at all.

If you've already "ripped" a stack of CDs but haven't created the tags, there are a number of ways you that can add them later. As always, the Internet is a good place to start looking for MP3-related stuff and we found what seemed like an endless variety of playlist and tag editor utilities. Some of the more elaborate solutions even include databases to make it easier to keep track of your collection.

Note that most MP3-related software supports several playlist and ID3 tag formats. For our Jukebox project, you should select 'M3U" as the playlist type and "ID3v1" as the tag format.

Winamp has a no-frills playlist and ID3 tag editor built right in, so let's look at it next.

Winamp to the rescue

For the purposes of demonstration, assume that we have six tracks from an audio CD, named "Track 01.mp3" through to "Track 06.mp3".

Start Winamp and open the Playlist Editor if it's not already displayed. To do so, click on the little "wave" symbol in the top lefthand corner of the main window. From the menu that appears, select "Playlist Editor".

All functions are accessed from the five buttons along the bottom bar. When any button is clicked, a pop-up list with further choices appears. To begin, clear any tracks already listed in the Playlist window by clicking on the *REM* button, and then clicking on *REM ALL* from the list that pops up.

Next, click the *ADD* button. From the pop-up list, click *ADD DIR*. An "Open Directory" dialog box appears. Find the directory that contains the MP3 files in question, click on the directory name to highlight it and then click the *OK* button. All the filenames

(tracks) now appear in the Playlist window (see Fig.1).

To edit the ID3 tag for any track, highlight it in the Playlist window and click on the *MISC* button. From the pop-up list, click *FILE INF* and then *File info*. The ID3 tag editor window appears, as shown in Fig.3. Click on the "ID3v1 Tag" checkbox, and complete the "Title" and "Artist" fields. Filling in the other fields is optional, as they are not used by the Jukebox. Click on the Update button to save the changes and then repeat for all tracks in the list. As each tag is completed, the new information is reflected in Winamp's Playlist window, as shown in Fig.2.

Note that Winamp includes many time-saving keyboard shortcuts. For example, you can open the tag editor for any track simply by highlighting it in the list and pressing **<Alt>+<3>** (hold down the **<Alt>** key and press **<3>**).

That's all there is to creating (or editing) the ID3 tags. Creating the playlist is even easier. Click on the *LIST OPTS* button and then the *SAVE LIST* button in the pop-up list. The "Save playlist" dialog box appears. Enter a descriptive name for the collection and click on the Save button.

By default, Winamp saves the playlist as type "M3U" and places it in the same directory as the MP3 files, which is exactly what we need for the Jukebox.

Metalists

Yes, we know it's not a real word but we're following in the tradition of other MP3 players by calling our playlist lists "metalists". Unlike playlists that contain lists of MP3 filenames, metalists contain lists of playlists. Metalists provide a simple means of organising your music into small, easily defined groups.

For example, suppose you have placed all your albums in separate directories, with each directory containing a playlist. You would then enter the full pathname of each playlist in the metalist file, which might look something like this:

```
D:\MP3\Favourites\Favourites.m3u
D:\MP3\Top of the Pops\Top of the Pops.m3u
D:\MP3\Party Hits\Party.m3u
```

A metalist is a simple text file that can be created with any text editor (such as Notepad). If you have a lot of playlists and hate typing, you can use

You can download lot's of skins for Winamp from www.winamp.com. Of course, you don't need these for the Jukebox (which can run without a screen) but they're lots of fun anyway.

good 'ol DOS to build the metalist for you by typing the following line at a command prompt:

```
DIR D:\*.M3U /B /S /O-D > D:\MP3\metalist1.txt
```

Replace the "D" in "D:*.M3U" with the drive that contains your MP3s, and if necessary change the metalist path to suit your directory structure. Metalist files can be placed anywhere (even on CD-ROM); they doesn't need to be saved in the same place as your MP3s. Also, notice how we've used a ".txt" extension for the metalist filename. This is so we can easily open it with a text editor for modification later.

If you have playlists on more than one drive, you can add another drive's lists to the metalist like this:

```
DIR E:\*.M3U /B /S /O-D >> D:\MP3\metalist1.txt
```

This adds all lists on the "E:" drive to the metalist created earlier.

Setting up IR remote control

If you're still with us, you will have installed Winamp and the IRRemote software, organised your MP3s and set up playlist(s). The final steps towards a working Jukebox involve setting up the IRRemote software.

Launch IRRemote from the Start menu or double-click on the "IR-Remote" shortcut on your desktop. The first time you run IRRemote, a dialog box appears with the message "Click Setup!".

Clicking on the *Setup* button opens the "IR Remote Setup" dialog box (see Fig.5). Settings are grouped together by function and made accessible via a series of tabs. Let's examine each tab in detail.

Basic settings

The area above the tabs lists a few basic settings that relate to the operation of the system as a whole. These settings are initialised with default values when the software is first loaded.

The "Enable LCD" option controls whether or not track data is sent to the LCD. By disabling this option, you can run the MP3 Jukebox with the IR receiver part of the hardware only (ie, without the LCD module installed).

If you've connected the IR Remote hardware to a serial port other than COM2, then select the correct port from the "Com Port" drop-down list. If you try to select a port that is already in use by other software, or if the IR Remote hardware is not connected to the designated port and powered on, then an error message will be displayed.

Using the "Key Timeout" settings drop-down list, select your preference for the time the software should wait between key presses on the remote before it "times out". We'll explain the purpose of this setting in a little more detail shortly.

Main tab

As there are considerable differences between remote control models, we decided to provide a means of manually assigning each key to a particular function.

The Main settings box lists an array of buttons, each identified by a particular function name. To program a particular key on your remote to perform a listed function, click on the associated button.

For example, to program the "play" function, click on the *Play* button. The "Program IR Remote Code" dialog box appears, as shown in Fig.6.

Point your remote at the IR Receiver and press the button that you want to use for the "Play" function. The green circle should flash to red and the decimal value of the key code should appear in the "Code" box. Note the *Disable* button; clicking it simply erases the programmed code and therefore disables the indicated function.

So far so good. Now program all of your remote's keys for the functions you intend to use in a similar fashion.

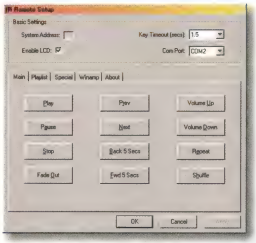


Fig.5: the first of five tabs in the IR Remote Setup window. This tab allows you to program the most-used Jukebox functions.

Fig.6: all keys are programmed via this window. You can change you mind as many times as you like, as every key press overwrites the last. The Disable button allows you to disable a previously programmed function.

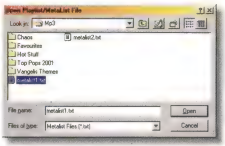


Fig.7: an Explorer-style window makes it easy to navigate to your playlist or metalist file.

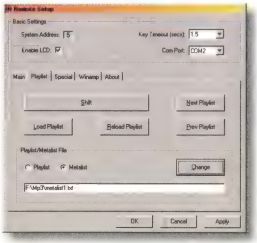


Fig.8: again, an array of buttons allows assignment of functions to keys on your remote. Grouped on this tab are all the functions that will allow you to navigate in a metalist.

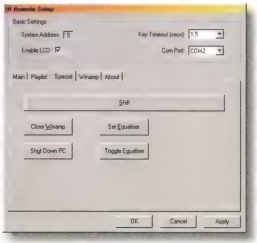


Fig.9: the least-used functions are assigned on the Special tab. Note the Shift button, which is a duplicate of the Shift button on the Playlist tab.

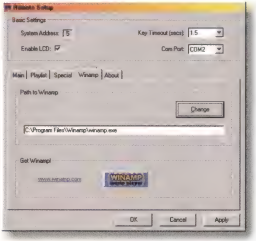


Fig.10: the last step involves defining the path to Winamp.

Fig.11: the About tab shows the software version and gives a plug for SILICON CHIP.

The choices that you make can be changed at any time, so feel free to experiment until you get a layout that is easy to remember and "feels right". Fig.4 shows the assignments we chose for our BC3000 remote.

By the way, the software doesn't check that you have programmed unique codes for each function. If you inadvertently use the same code for two or more functions, then only one of them will work.

We should also mention that some remotes have a TV-only mute key – often called a "punch-through" mute – that you can't use with IR Remote. It always transmits the TV system address, regardless of which equipment group (mode) you've selected.

You may remember from our description of the RC5 remote control system last month that all key codes are transmitted with a system address. This address translates to the currently selected equipment group, or in other words, the last mode button you pressed (TV, VCR, CD, etc). IR Remote saves the address of the first key that you program as its address, allowing it to masquerade as any type of equipment.

If you want to experiment with different remote controls, then you may need to switch modes, say from "VCR" to "CD". To have IR Remote respond to the new address, all you need to do is reprogram a single key. During programming, you will get the message "System address change detected, save changes?" Click *OK* and you will see the new address appear under "Basic Settings".

Playlist tab

We found that after assigning the most common functions on our remote, we had used all available keys. We needed more keys! A simple solution was to define one key as a "shift" key, so that pressing it first means that the next key takes on a new, or "shifted" function. This is analogous to the **<Shift>** key on a keyboard selecting between upper and lower case characters.

The Playlist tab includes a button for programming the **<Shift>** key (see Fig.8). The key you decide to use for the shift function must not be defined for any other function. On our BC3000 remote, we used the **<TV/AV>** key.

In use, to execute any of the functions listed on this tab, you need to press the **<Shift>** key first followed by the key for the particular function, all within the key timeout period. If you don't press the second key within the timeout period, then instead of getting the shifted function, you'll get the unshifted function.

The important point is, of course, that you can assign all of the functions on this tab to keys that you've already assigned on the Main tab.

So what do these functions do, exactly? Well, "Load Playlist" allows you to load a specific playlist number. Playlists are automatically assigned numbers according to the position that they appear in the metalist. In use, you need to press the **<Shift>** key, followed by one (or two) digits, followed by the key that you assign to this function.

"Reload Playlist" closes and then reopens the defined playlist or metalist. It is intended for cases where the playlist(s) are on CD-ROM, and you want to swap the disc without having to restart the software.

"Next Playlist" and "Prev Playlist" simply move forward and back in the metalist.

To complete the settings on this tab, you need to "tell" the software which playlist or metalist file to load when it starts. If you have created a metalist, then click on the "Metalist" option button. Alternatively, if you want to load a single playlist (.m3u) file, then click on the "Playlist" option button.

Next, click on the *Change* button to bring up the "**Open Playlist/Metalist File**" dialog box (see Fig.7). Navigate to wherever you saved the playlist or metalist, click on it to highlight it and then click the *OK* button. That's it – done!

Fig.12: the only trace you'll find of IR Remote after it starts is an icon in the System Tray.

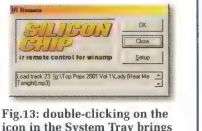


Fig.13: double-clicking on the icon in the System Tray brings up this window. From here you can close IR Remote, run setup or just examine the event log.

Special tab

All the least-used functions are grouped on this tab (see Fig.9). As with the Playlist tab, the functions on this tab are "shifted". The Shift button is just a duplicate of the Shift button on the Playlist tab, so if you've already assigned a <Shift> key, there's no need to do it again here.

Apart from the "Set Equaliser" function, which we describe in detail later, the names of the buttons give good indication as to what each function might do. As before, assign each function that you want to use to a key on your remote.

Winamp tab

Our last stop is the Winamp tab (see Fig.10). In order for IR Remote to be able to start Winamp, we need to "tell" it where to find the Winamp program (executable).

Click on the *Change* button and the "Find Winamp Executable" dialog appears. Notice how it automatically opens the **C:\Program Files\Winamp** directory, which is the default installation directory.

If you opted to install Winamp elsewhere, then navigate to that directory now. Select the **winamp.exe** file in the displayed list of files and then click the *OK* button.

About tab

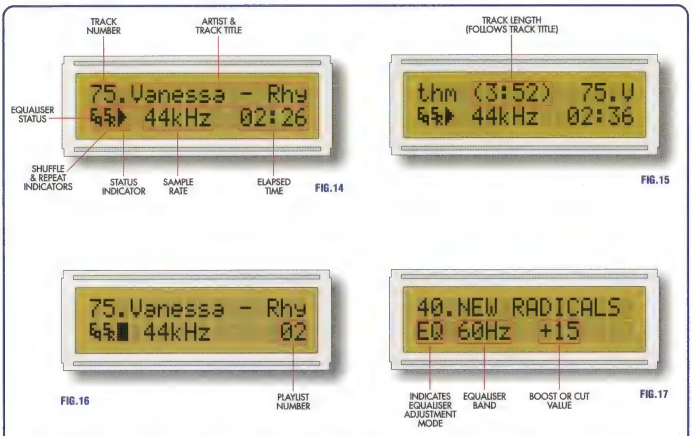
IR Remote Control for Winamp was written in Microsoft Visual Basic Professional V6 and the installer was scripted with Nullsoft's NSIS v1.44.

Congratulations! Click on the *OK* button at the bottom of the main window to start your Jukebox!

Driving IR Remote

We've designed IR Remote so that it's virtually hands-free. In normal operation, it starts and minimises Winamp (shrinks it to the taskbar) and then shrinks itself to an icon in the System Tray (see Fig.12). You don't need to use your mouse or keyboard, or even be able to see your monitor.

If something does go wrong, or you want to run setup again, just double-click on the IR Remote icon in the System Tray, and the status dialog appears (see Fig.13). A small two-line



Figs.14 - 17: interpreting the LCD readout. The top line scrolls left, displaying the current track number, artist, title and track length. The bottom line displays status information, except when in equaliser adjustment mode.

text box at the bottom provides a glimpse into the internal workings. Up and down arrows on the right-hand side allow you to scroll forward and back in a list of recent events. This list can be a useful aid in determining why a particular playlist or track has failed to load.

It is important to note that when IR Remote is running, you should not change any settings in Winamp's Main or Playlist windows. Although it is possible to change a few basic settings like the volume and equaliser sliders, clicking on buttons such as *Play* or *Stop* or changing the playlist will confuse IR Remote and you may have to restart to recover.

You can safely change plug-in, visualization and skin settings, as well as the preamp and balance controls (see "Setting the Equaliser" below).

Another potential problem arises if you insert an audio CD when IR Remote is running. By default, Winamp associates itself with audio CDs when installed, even if you were previously using an alternate program to perform this function. Therefore, it automatically loads all the CD's audio tracks into the playlist and as IR Remote knows nothing about audio CDs, the results are unpredictable!

Interpreting the LCD readout

Fingers crossed, you'll now have a working Jukebox, so let's look at how to interpret the track data shown on the LCD readout.

When you start IR Remote, it automatically loads the last playlist used and from that list loads the very first track. The track number, track title, artist and track length are all displayed on the top line.

As we only have 16 characters to display all this information, the top line continually scrolls left to make it all visible (see Figs.14 & 15).

When IR Remote loads a track that does not include a valid ID3v1 tag, it cannot display title and artist information. Instead, the track's filename is displayed.

The bottom line

Reading from left to right, we first encounter the equaliser status symbol. This is displayed whenever Winamp's equaliser is enabled. Next to this are the shuffle and repeat indicators. When track shuffling is enabled, a small "S" is visible, and when playlist repeat is enabled, a small "R" is visible.

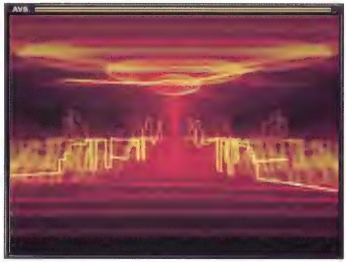
Moving right along, we find the status indicator. This indicator displays the traditional Play/Pause/Stop symbols, as appropriate.

In the middle, we find the track sample rate. Note that both the track sample rate and track length (on the top line) may not be displayed until after playing begins.

Finally, the right corner displays either elapsed time in seconds when playing or paused, or the currently

Where To Buy A Kit

Kits for the IR Remote Receiver & Display will be available from Altronics, 174 Roe St, Perth, WA. This kit will include the LCD, the PC board, a programmed microcontroller and all on-board parts.



Blow your mind with Winamp's full-screen Visualizations. You can use the in-built samples, download them or define your own but you'll need a fast PC.

loaded playlist number when stopped (see Fig.16). If you specified just a single playlist (.m3u) file during setup rather than a metalist, then obviously the playlist number will always read "01".

Setting the Equaliser

Winamp includes a cool 10-band equaliser that can be adjusted with your remote control. To enter adjustment mode, hit the **<Shift>** and then **<Set Equaliser>** keys on your remote (assuming you programmed this function during setup). The bottom LCD line now displays the last selected equaliser band and a boost/cut value between +31 and -32 (see Fig.17).

To select a particular band for adjustment, simply press a digit between 0 and 9, with 0 representing the lowest band (60Hz) and 9 the highest (16kHz). By using the **<Next>** and **<Prev>** keys, you can boost or cut the displayed band as desired. To exit equaliser adjustment mode, press **<Shift>** followed by **<Set Equaliser>** again. To hear the results, the equaliser must be enabled. Use **<Shift>** followed by **<Toggle equaliser>** to toggle it on/off.

If you happen to have Winamp's equaliser displayed on-screen when setting a band, you'll notice that the associated slider does not move in unison. We couldn't figure out how to get Winamp to update it's sliders in real time but as the Jukebox is designed to be operated without using the Windows interface, we weren't too concerned about this anomaly.

Note that we haven't provided remote control of Winamp's preamp or balance controls but you can set these manually in Winamp and they will be reloaded each time Winamp starts.

Remote control hints & tips

The MP3 Jukebox gives you complete control over your playlist and track selections. Normally, the order that tracks appear in the playlist is the order in which they are played and playlist editors allow you to sort and order these as you wish. What about when the Jukebox is playing, though?

If you know the number of the track you want, simply punch in its number. If the selected number is less than 100, then there will be a short pause (the key timeout period) before it is played. Alternatively, follow with **<Play>** to play it immediately. If you want to mix things up a bit, then hit the **<Shuffle>** key. This plays all tracks (that haven't already been played in the current pass) in random order. You can even move forward and back in the random list.

To hear the same song over again, hit **<Play>** just before it ends. To hear the same playlist over again, hit **<Repeat>**. To load another playlist, press **<Shift>** followed by the playlist number. Optionally, follow this with **<Load Playlist>** to bypass the key timeout delay.

You can also use **<Shift>** followed by **<Next Playlist>** or **<Prev Playlist>** to skip forward and back in the metalist.

Problems?

You might find that the Jukebox seems to ignore the occasional key press. What's going on? Well, there are a number of possible explanations. Firstly, the RC5 remote control system used here is not an "error-free" transmission system. So if the IR receiver gets only part of a code or a "distorted" code (caused by reflections or interference from other light sources), then the code eventually passed on to the Jukebox could be unintended.

Secondly, most remotes have "hair trigger" buttons; one press can sometimes transmit a second (or even third) unintended keystroke. We've also noticed that the time that a key is pressed before it automatically repeats is extremely short, so you almost need to "stab" a key to get just a single code.

Lastly, when we designed the IR Remote Receiver we noticed significant differences between brands of IR receiver chips. We specified two alternates in the parts list, one from Dick Smith Electronics (Z-1955) and one from Jaycar Electronics (ZD-1952). We found that the Z-1955 has greater range than the ZD-1952 but at the expense of overall accuracy. In use, it was able to pick up transmissions reflected off the ceiling and nearby walls but many of them were decoded incorrectly.

Food for thought

Thinking of building a standalone Jukebox without a monitor or keyboard? We designed the Jukebox so that once you've set everything up, you can!

To run your PC without a monitor or keyboard, you'll probably need to alter your BIOS settings so that it will boot without these devices connected. Generally, the setting to look for is titled "Halt On"; change the associated parameter to "No Errors". Check your motherboard manual for specific details.

On the Windows side, you need to boot up at least once without a mouse connected to disable Windows' mouse warning message. Of course, you also need to make sure that the system automatically logs-on when Windows starts.

One way to do this is with the "TweakUI" utility from Microsoft. It allows you to set up auto-logon and includes lots of other useful stuff too. You can download it from **www.microsoft.com/ntworkstation/downloads/powertoys/networking/nttweakui.asp**

Finally, you'll need to place a shortcut to the **IRRemote.exe** file in

your startup folder if you didn't choose the "load at startup" option during installation.

How do I update my music?

You're probably wondering how you're going to update your MP3s without a monitor or keyboard connected. The simplest method of all is to store your MP3s on CD-ROM. Then all you need to do to update is to burn a new CD, switch discs and hit the <Shift> <Reload Playlist> keys on your remote. You don't need to run IR Remote Setup again as long as the metalist file retains the same name and location on the disc.

While on the subject of CDs, we mentioned in the introduction that you might get short pauses in play when running from a CD-ROM drive. If you have this problem, then try increasing the output buffer size in Winamp. To alter this setting, open Winamp's Preferences window. Under Plug-ins, select the "Nullsoft waveout plug-in" and click on the *Configure* button. Now change the "Buffer length" slider from the default of 2000ms to about 8000ms. That should do the trick!

If you want to go the whole hog, then what about a home network? Networking kits are quite cheap these days and updating the Jukebox files across a network is a snap!

Once networked, you can control the Windows desktop of your Jukebox from another PC on the same network using an excellent freeware package called VNC (Virtual Network Computing). Check it out at **http://www.uk.research.att.com/vnc/**

Remote mounting

If you want a super-professional look, you could mount the IR Remote Receiver & LCD hardware in a small rack-mount or instrument case and stash that old beige PC box out of sight. Power requirements are modest (less than 100mA) and can be provided by any 9-12V DC plugpack. The serial cable can be as long as you like but not so the audio cable from the sound card. Keep this down to a few metres to avoid potential noise and signal loss problems.

We took the alternative route of fitting the hardware to a PC which we resprayed charcoal grey.

Hey Mr DJ!

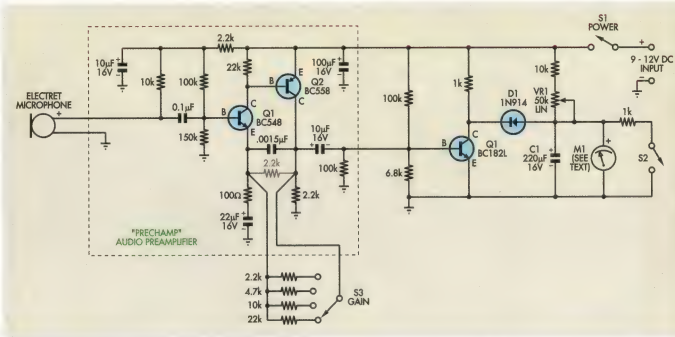
Yes, the Jukebox even has a party mode (well, almost!). The clever people at Nullsoft designed Winamp so that it is easily expandable using plug-in software modules, or "plug-ins" for short. One in particular, called "SqrSoft Advanced Crossfading", is a good example of how useful these can be.

Once installed, this plug-in allows you to eliminate the short gap between tracks, as well as automatically fade out a track as it ends and fade in the next. A word of warning, though. Make sure you are very familiar with the operation of Winamp and the Jukebox before you try this plug-in, as it changes the operation of things considerably.

You can download this and other plug-ins of interest from the Winamp web site; follow the link to the plug-ins download page. Enjoy! **SC**

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Sound source locator uses PreChamp

This circuit could be regarded as a simple alternative to the Sooper Snooper device featured elsewhere in this issue. It is based on the PreChamp preamplifier featured in the July 1994 issue of SILICON CHIP. It can be used to pinpoint or locate sounds coming from inconspicuous sources such as a noisy bearing in a VCR containing many bearings.

Other examples are an audible gas leak or a puncture in a slowly deflating tyre, provided the background noise level is considerably less than the source noise.

The device uses an electret microphone. This is attached to the end of round Texta casing of the same diameter, then covered with spaghetti sleeving and overlapping the electret by 5mm to make it more directional.

The electret was then wired to the two-transistor Pre-Champ preamplifier (available from Dick Smith Electronics, Jaycar & Altronics as a kit). The 2.2kΩ feedback resistor in the preamplifier is replaced with switch S1 and four resistors – 2.2kΩ, 4.7kΩ, 10kΩ and 22kΩ – to give gains of 23, 48, 101 and 221, respectively.

After passing through the modified PreChamp, the signal goes to the base of Q1 which is biased on the verge of turning on by the 100kΩ and 6.8kΩ resistors. When the electret microphone picks up a sound, the amplified signal is fed to the base of Q1 turning it on and drawing current via diode D1 to reduce the stored charge in C1, the 220µF electrolytic capacitor. This results in a dip in the reading of analog meter M1.

Meanwhile C1 is constantly being charged via the 10kΩ resistor and the 50kΩ trimpot VR1. VR1 is set to provide full scale deflection on meter M1 when no signal is present. If a 50uA meter movement is used it will required a suitable shunt resistor to suit the circuit.

Summing up, as the unit is used to home in on a sound source, louder sounds cause the meter reading to drop. Frequencies below 20Hz will cause the meter pointer to flutter.

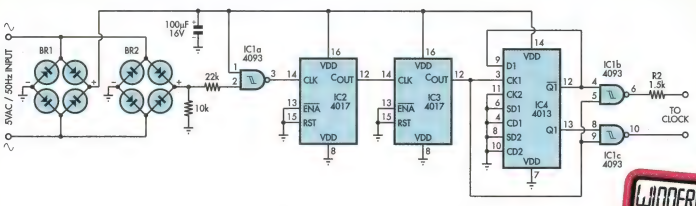
Switch S2 and the associated 1kΩ resistor are provided to quickly discharge C1 to enable repeated measurements.

P. Hetrelezis,
Noble Park, Vic. ($30)

CONTRIBUTE AND WIN!

As you can see, we pay good money for each of the "Circuit Notebook" contributions published. But now there's an even better reason to send in your circuit idea: each month, the best contribution published will win one of these superb Wavetek Meterman 85XT true RMS multimeters - valued at around $380! So don't keep that brilliant circuit secret any more: send it to SILICON CHIP and you could be a winner!

Contributions must be your own original work or a major adaptation and not published elsewhere nor submitted for publication elsewhere. SILICON CHIP's decision is final.



Building a synchronous clock

The quartz clocks which have dominated time-keeping for the past 20 years or so have one problem: their errors, although slight, are cumulative. After running for several months the errors can be significant. Sometimes you can correct these if you can slightly tweak the crystal frequency but otherwise you are forced to reset the clock at regular intervals.

By contrast, mains-powered synchronous clocks are kept accurate by the 50Hz mains distribution system and they are very reliable, except of course, when a blackout occurs. This circuit converts a quartz clock to synchronous mains operation, so that you can have at least one clock in your home which shows *the* time.

First, you need to obtain a quartz clock movement and disassemble it down to the PC board. For instructions on how to do this, see the article on a "Fast Clock For Railway Modellers" in the December 1996 issue of SILICON CHIP. Then isolate the two wires to the clock coil and solder two light duty insulated hookup wires to them (eg, two strands of rainbow cable). Drill a small hole in the clock case and pass the wires through them. Then reassemble the clock case.

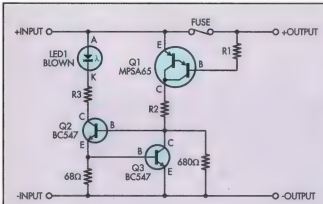
To test the movement, touch the wires to the terminals of an AA cell, then reverse the wires and touch the cell terminals again. The clock second hand should advance on each connection.

The circuit is driven by a low voltage AC plugpack. Its AC output is fed to two bridge rectifiers: BR1 provides the DC supply while BR2 provides positive-going pulses at 100Hz to IC1a, a 4093 NAND Schmitt trigger. IC1a squares up the 100Hz pulses and feeds them to the clock input of the cascaded 4017 decade counters. The output at pin 12 of IC3 is 1Hz.

This is fed to IC4, a 4013 D-type flipflop, which is connected so that its two outputs at pins 12 & 13 each go positive for one second at a time. As these pulses are too long to drive the clock movement directly, the outputs are each fed to 4093 NAND gates IC1b & IC1c where they are gated with the pin 3 signal to IC4.

This results in short pulses from pins 3 & 10 of IC1 which drives the clock via limiting resistor R1. The value of R1 should be selected on test, allowing just enough current to reliably drive the clock movement.

A. J. Lowe,
Bardon, Qld.



Blown fuse indicator

This blown fuse indicator will work with a wide range of DC supply voltages from 5V to 50V. It illuminates LED1 when the fuse blows. With the fuse intact, Q1 is held off and there is no bias current available for the base of Q2. So the LED is off.

When the fuse blows, a small current flows via the base-emitter junctions of Darlington transistor Q1, through its base resistor R1 and then via the load. Typically this current will be around 20µA and this turns on Q1 which provides base current to Q2 which then turns on to illuminate the LED.

The emitter current of Q2 is limited by Q3 which turns when the current reaches about 10mA, to shunt base current away from Q2.

The three resistor values not given in the circuit are dependent on the supply voltage and can be calculated from the following simple equations:

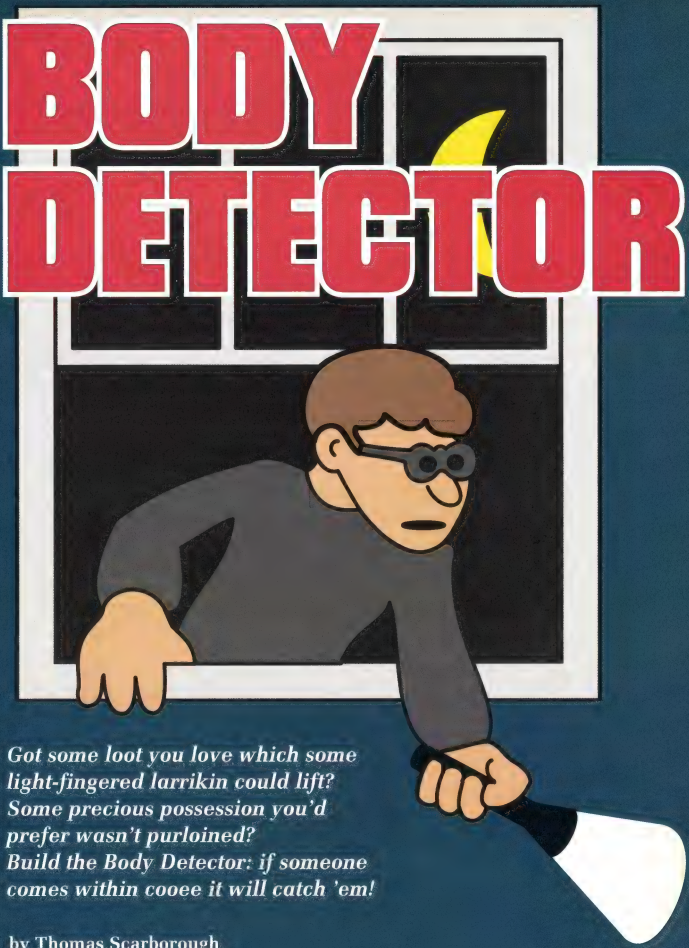
R1(kΩ) = V(DC)/0.02 = 560kΩ for 12V DC
R2(kΩ) = V(DC)/2 = 5.6kΩ for 12V DC
R3(Ω) = V(DC)/0.02 = 560Ω for 12V DC

R3 should be included for voltages above about 20V otherwise the heat dissipation in Q2 will be too great. At lower voltages it can be omitted.

Any general purpose NPN transistors can be used for Q2 and Q3, provided they will handle the DC supply voltage. The PNP Darlington, Q1, could be an MPSA65, available from Dick Smith Electronics (Cat Z-2088).

Keith Gooley,
via email. ($40)

BODY DETECTOR



Got some loot you love which some light-fingered larrikin could lift? Some precious possession you'd prefer wasn't purloined? Build the Body Detector: if someone comes within cooee it will catch 'em!

by Thomas Scarborough

Every human body is surrounded by an electric field – a stronger field than many people would expect. With some simple test equipment, I was able to measure this field up to a metre away.

The phenomenon of capacitance is entirely dependent on the existence of electric fields. If a human body should approach one plate of a capacitor, the body's electric field can inter-react with that of the capacitor and can cause the capacitance to increase. Again, this may easily be detected.

Further, any number of metal objects may be attached to one plate of a capacitor, for example a sheet of aluminium foil or even a set of window security bars. These then become an extension of that plate.

In our Body Detector circuit, we call these the sensor. In this design it is attached to the positive plate of a capacitor.

While in theory the Body Detector is dependent on the electric field which surrounds the human body, in effect it's as if an invisible field surrounds the sensor – somewhat like the "invisible" defence shields seen in the latest Star Wars movie.

The principle employed here is different to alarms which detect EMF-induced eddy currents in the body. Because the Body Detector is based on the principle of body capacitance it has a high degree of immunity to AC fields, as well as being able to function well out of range of such fields.

Interesting effects

The electric field which surrounds the human body has a number of interesting and useful effects.

Our Body Detector is housed in a small plastic case with sensitivity control, mini piezo buzzer and activation LED on the front panel.

Firstly, when the body comes into direct contact with a metal object, its electric field is transferred to the object concerned. This object is instantly surrounded by an electric field, as though it were the human body itself.

Therefore, as far as the Body Detector is concerned, such a metal object becomes indistinguishable from a human body, and the Body Detector may be "tricked" into thinking that a human has come near.

As an example, if a sheet of aluminium foil is used for the sensor and this is placed underneath a table with a drink can on top, the Body Detector will reliably pick up a hand approaching the can. Even more useful than this, the effect could be used to protect, say, a silver tea service or a jewellery display, without any visible sign of an alarm system being present.

Secondly, the average tabletop (with some exceptions) is an insulator – and of course electric fields work through insulators. A capacitor is the prime example of a device that is entirely dependent for its operation on an insulator – in this case the dielectric.

The fact that the Body Detector is able to act through an insulator illustrates its effectiveness through insulators in general – it will work through materials such as glass, wood, plaster, cloth, carpet or even cement. This could prove very useful in certain applications – for instance, for detecting fingers approaching a valuable paint-

SOME POSSIBLE APPLICATIONS . . .

- Intruder alarm, triggered when a doorknob is touched.
- "Pressureless" pressure mat, to detect a person passing over it, or past it. As the Body Detector may be cascaded, this could extend across an entire office floor.
- An invisible "panic plate", set inside a concrete wall. Such a plate would be extremely difficult to detect.
- A safety switch, to render an area a safety zone, with the possibility of shutting down dangerous machinery or child-proofing certain areas.
- An anti-thief alarm, to protect a variety of metal items of value; eg, a computer, or silver tea service.
- A bicycle alarm, triggered as soon as a bicycle is touched – anywhere.
- An anti-tamper alarm, triggered even before a door lock or padlock can be touched.
- An "off limits" alarm, to protect valuables from theft or abuse.
- Anti-kidnap alarm; a child fitted with the Body Detector could not be touched without triggering an alarm.
- A switch for a low-voltage bedside or night light. A large sensor would trigger the light merely with the wave of a hand in the right direction. (Note: this device is not suitable for switching mains-powered devices).

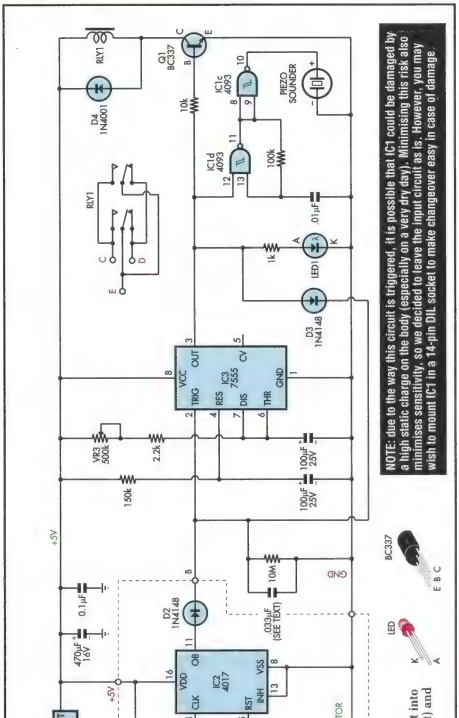


Fig. 1: the Body Detector can be split into two parts – the detection circuit (left) and the alarm circuit (right).

ing, or for detecting feet passing over a carpet – or even for detecting a hand placed over an invisible "panic plate" hidden in the wall or floor.

Finally, and paradoxically, the human body itself may serve as a sensor, with its own electric field being swamped by that of another body. So the Body Detector could, for instance, be strapped to the ankle of an infant, and would serve as an anti-kidnap alarm.

I first tested this concept on my 15-year-old son, to very good effect. I was not able to touch him even with the tip of a finger without triggering the Body Detector. He immediately requested such a unit for school, so that whenever anyone would touch him or prod him in class, an alarm would sound!

Circuit application

The simplicity of the circuit (see Fig. 1) is deceptive.

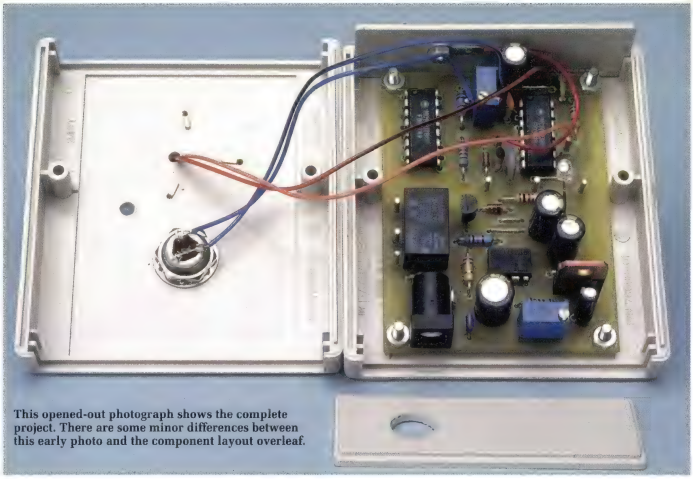
I developed two previous versions of the Body Detector, one of which was published worldwide. This design is fundamentally different to the previous two, and represents a significant improvement over both.

This circuit is in the "super-sensitive" category. I was able, with careful tuning, to cause the Body Detector to trigger on the approach of a person well over half a metre away.

For practical purposes, however, the Body Detector will reliably pick up a hand (or a foot) approaching a 300mm x 300mm sheet of aluminium foil at a distance of 200mm – or a hand approaching a computer system unit at a few centimetres. One does not need more than this to be able to put the Body Detector to very good use.

A special feature of this design is that it may also be cascaded. For instance, it may be used to sense a number of security bars around a home, or more than one area of carpet at once. All that is required is a length of three-way cable to connect separate sensor units, which are then connected in parallel. More on this shortly.

Note that there is a limit to the mass of metal objects which may serve as sensors. A bicycle would probably represent the practical upper limit, although I managed to adjust the Body Detector for short periods of time to sensors up to 250kg, with hair-trigger tuning. The biggest such "sensor" was a three-wheel pick-up that I used to



This opened-out photograph shows the complete project. There are some minor differences between this early photo and the component layout overleaf.

drive (which was sadly written off shortly before I completed this article!).

The Body Detector has been specially designed with a wide variety of possible applications in mind. For this reason, it incorporates a relay which may switch low voltage devices in its own right, or switch a further (external) mains-rated relay. On the other hand, if REG1 is replaced with a micropower regulator (eg, the LP2950CZ), it could also be used for long-term battery use – for instance, when used as a bicycle alarm.

If the specified regulator is used, any DC power supply (regulated or unregulated) between 7V to 20V may be used. In this case, the Body Detector will draw less than 10mA on standby. With a micropower regulator, it would draw less than 3mA on standby, which would enable it to operate continuously for more than a week from a small alkaline 9V battery. When triggered, the circuit draws around 70mA.

Circuit description

The circuit diagram of Fig.1 is virtually self-explanatory, so no block diagram is shown.

Clock generator IC1a clocks decade counter IC2 at approximately 2MHz. Clock generator IC1b resets decade counter IC2 at about 200kHz. This means that IC2 is sequenced very rapidly from 0 to 9, then reset at around the count of 9.

If, however, a human body comes close enough to the 1.8pF sensing capacitor (connected to PC stake "A"), the capacitance rises and the frequency of clock generator IC1a drops to around 1MHz. Clock generator IC1b, however, continues at the same frequency, so that IC2 now resets around the count of 4.

This means that IC2's outputs 5 to 9 no longer go high (logic 1) and this can easily be detected and used to trigger a relay.

The bigger the sensor that is attached to the Body Detector, the lower the "quiescent" operating frequency of clock generator IC1a. If a 330mm x 330mm sheet of aluminium foil is used as the sensor, the "quiescent" operating frequency will drop to around 1MHz – dropping a further 500kHz when a body comes into direct contact with the foil.

This "quiescent" operating frequency will drop even further with larger metal sensors – therefore VR1 and VR2 are provided to adjust IC1b to various frequencies, so that IC2 will continue to reset around the count of 9, whatever the size of the chosen sensor. VR2 serves as a "fine tune".

IC2's output, pin 11, has a 10% duty cycle (that is, it goes high about one tenth of the time). The 0.033µF capacitor therefore "bridges" these pulses at pin 11, causing IC3 pin 2 to go high continually. But if decade counter IC2 resets before the count of 9 (eg, when a hand approaches the sensor), pin 2 of IC3 goes low, and the monostable timer is triggered.

The output terminal of IC3 switches the relay via Q1, activates oscillator IC1c-IC1d, and illuminates LED1. The piezo alarm is optional – this would be useful particularly when testing the Body Detector when it is out of the line of sight, for instance when testing security bars from outside of a house when the Body Detector is mounted inside.

Parts List – Body Detector

1 PC board, 70 x 50mm coded 03110011
1 Small plastic case, (RS 284-6482 or equivalent)
1 DPDT relay, mini DIL PCB mount, 5V coil (RLY1) (Altronics S4128)
1 Low-profile piezo sounder (RS 249-889)
1 2.1mm PC-mount DC power socket
5 M2.5 nylon nuts and 10mm bolts
11 PC stakes
Insulated hookup wire, various colours.
Dual-in-line IC sockets if desired
Aluminium foil (optional)
9V-12V battery or power supply (optional)
2.1mm power plug (optional)

Semiconductors
1 MC14093BCP Schmitt trigger (IC1) Motorola brand (see text).
1 MC14017BCP decimal counter (IC2)
1 7555 CMOS timer (IC3)
1 LM7805 5V positive regulator (REG1)
(or LP2950CZ 5V positive regulator – see text)
1 BC337 NPN transistor (Q1)
2 1N4148 diodes (D1, D4)
2 1N4001 diode (D2, D3)
1 3mm red LED (LED1)

Capacitors
1 470µF 16VW PC electrolytic
4 100µF 25VW PC electrolytic
1 0.1µF ceramic
1 .033µF ceramic (see text)
1 .01µF ceramic
1 100pF ceramic
1 1.8pF ceramic

Resistors (0.25W 10%)
1 10MΩ 1 150kΩ 1 100kΩ 2 10kΩ
1 8.2kΩ 1 2.2kΩ 1 1kΩ
2 500kΩ top-adjust 25-turn trimpots (VR1, VR3) (Altronics R2392A)
1 10kΩ cermet (miniature) potentiometer (VR2)

A short delay is provided at switch-on through the 150kΩ resistor and 100µF capacitor connecting to IC3's reset (pin 4). This arrangement produces a negative pulse for a few seconds, so that the user has sufficient time to step out of range when the Body Detector is powered up.

With the component values shown, monostable timer IC3 (and therefore the relay's "on" time) may be adjusted over a useful 150ms to 30 seconds. If different timing periods are required, the value of the 100µF capacitor may be increased for longer time periods (and vice versa).

The output of monostable IC3 provides current for switching transistor Q1, which in turn controls relay RLY1.

Regulator REG1 is employed especially to ensure stability for clock generators IC1a and IC1b. The specified device consumes around 7mA. Any similar 5V positive regulator may be used, provided that it is rated 150mA upwards.

My experience is that it makes quite a difference which brand of 4093 IC is used. The one specified here is manufactured by Motorola. Other makes may not function properly.

Circuit stability

Stability is a challenge with any circuit of this order of sensitivity. This is because the quantity being measured – in this case body capacitance – is so small that minute variations within the circuit itself may swamp the quantity being measured.

This circuit largely overcomes the twin problems of temperature variations and supply voltage fluctuations in such a way that it attains an unusually high degree of stability. Each of my previous designs convincingly solved only one or the other of these two problems – this one overcomes both.

Firstly, the frequency of clock generator IC1a is converted to a decimal number through decade counter IC2. Then it is effectively compared with itself over time – typically 50 times per millisecond. This yields far better results than if a standard beat frequency oscillator (BFO) is used.

Secondly, the fast clock generator IC1a is built almost identical to the slower clock generator IC1b, so that any temperature variations in IC1a are more or less mirrored in IC1b. As far as possible, the temperature coefficients of all the capacitors and resistors surrounding these two gates should be matched – this is important. I used a relatively expensive potentiometer for VR2, so as to match its temperature coefficient to the other resistors surrounding IC1a and IC1b.

Thirdly, the .033µF capacitor is used to mask the effects of voltage transients, by damping any voltage-induced jumps in clock generator IC1a. In fact this capacitor, although it is only one component, is crucial to the functioning of this circuit, since transients would otherwise render the circuit unstable, particularly at higher sensitivities.

This may be appreciated by tapping the sensor very rapidly. If it is tapped rapidly enough (thus mimicking a transient), the Body Detector will fail to trigger.

The value of this capacitor may be increased in some applications (for instance, when used as a bicycle alarm) to about 0.1µF. This creates a delay of two or three seconds before monostable IC3 triggers, leaving just enough time to switch off the alarm before it triggers.

One final threat to the circuit's stability came from the switching actions of IC3 and the relay. In fact, initially, this seriously interfered with the functioning of the circuit. Therefore D3 is employed in such a way as to take IC3's trigger input pin 2 high (logic 1) when monostable IC3 triggers. Pin 2 then remains high for a fraction of a second after the timing period has ended. This effectively masks the switching actions of IC3 and the relay.

The effect of D3 may be appreciated by holding your hand to the sensor

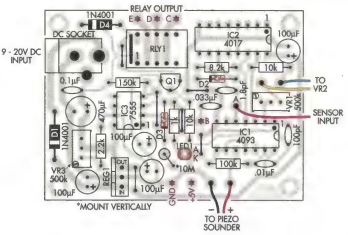


Fig.2: here's how it all goes together on the PC board. Note that there are a few differences between this version and the early prototypes photographed.

continually. As IC3's timing period comes to an end and LED1 extinguishes, a fraction of a second's delay is seen before LED1 illuminates again.

These measures to a large extent make the Body Detector free from temperature and supply voltage variations. A prototype of the Body Detector was tested over a 70°C temperature range (-20°C to +50°C) at a useful sensitivity, using a 300mm x 300mm sheet of aluminium foil as the sensor and there was no spurious triggering.

Construction

The Body Detector is built up on a single PC board measuring about 70mm x 50mm and coded 03110011. Details of the component layout are shown in Fig.2. All the components should fit into place without difficulty.

First solder the link wires and solder pins, the power socket, resistors, presets and relay, then the diodes and LED, continuing with the capacitors and transistor. Attach VR2 and the piezo sounder to the relevant solder pins by means of insulated hookup wire cut to suitable lengths.

LED1 was soldered to PC pins in such a way as to slot directly through an appropriate hole drilled in the top of the plastic case.

Finally, solder the ICs into place, being careful not to overheat any of the pins. Dual-in-line sockets may be used if desired. Observe anti-static precautions, the most important of which is to ground your body immediately before handling these devices (a simple solution would be to touch a metal tap).

If the specified case is used, regulator REG1's pins need to be inserted deeply into the PC board to provide maximum headroom. Finally, bolt a solder tag to the case, connecting this to solder pin A by means of a short length of wire.

Be careful to observe the correct polarity of the electrolytic capacitors, and the correct orientation of Q1, the diodes and ICs. The cathodes of the diodes are banded, while the anode of LED1 has the longest lead.

Finally, check that there are no solder bridges on the board.

The Body Detector may be housed in a suitable case, with VR2 being mounted on the front panel for easy fine-tuning. The piezo sounder and LED1 may also be mounted on the front panel. The PC board is fixed to the bottom of the case with four small nuts and bolts.

A hole is drilled in the side of the case to expose the power supply socket while the sensor solder pin is attached to the side of the case by means of a small bolt and solder tag.

Note that the tag should not be soldered while on the case – it may melt the plastic.

The relay outputs are routed to three solder pins on the PC board (pins C to E), and these may be used to wire up an external load. You could drill an appropriate hole in the side of the enclosure, or to use a suitable socket.

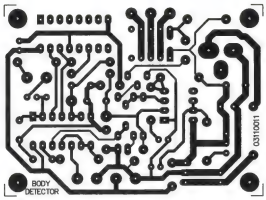
Calibration

Begin by turning VR1 and VR3 fully anti-clockwise, and VR2 to a centre position.

Plug in the power supply, which is a regulated or unregulated DC supply between 9V and 20V if the specified regulator is used (a regulated supply is better – 9V or 12V is ideal). Be sure to observe the correct polarity. If at any time the circuit does not behave as described, switch off immediately, and check the wiring carefully.

Now turn up multi-turn preset pot VR1 (this may require several clockwise turns) until LED 1 illuminates and the piezo buzzer sounds. Then back

The input to the Body Detector is this case-mounted solder lug, which can be connected to a range of "sensors" as discussed in the text. The lug should not be soldered "in situ" because you may well melt the plastic case. Fairly obviously, this pic was taken before we glued the front panel label in place.



The full-size PC board pattern can be used to check commercial boards or, if you're keen, to make your own. Likewise, the front panel (right) can also be used "as is" or a photocopy made. Both the PC board artwork and front panel artwork can also be downloaded from www.siliconchip.com.au

off VR1 until the piezo *just stops* sounding. Touch the solder tag which is wired to solder pin A with a moist finger. The sounder should now beep and the LED illuminate. Next, connect the "sensor" tag (which is wired to solder pin A) to a sensor; eg, a sheet of aluminium foil about 300mm x 300mm is ideal.

Note again that it is vitally important that there should be a good connection between the sensor and circuit board, otherwise adjustment could be a hit and miss affair. If possible, use soldered connections.

The piezo sounder should now be making noise and the LED should illuminate. Now slowly turn multi-turn preset pot VR1 anti-clockwise until the piezo sounder falls silent, and the LED extinguishes. Your body may affect the tuning, so use a plastic or insulated screwdriver and stand back from the circuit from time to time to see whether the piezo sounder falls silent.

Too large a sensor (eg, the kitchen stove!) could exceed the range of the circuit, so that the LED does not extinguish – the circuit's range can be extended by increasing the value of C3.

Adjust preset VR1 in such a way that potentiometer VR2 (on the front panel) continually triggers the circuit when turned fully clockwise but barely triggers it when turned back. VR1 is used to roughly match the circuit to a given sensor while VR2 is used for fine-tuning thereafter.

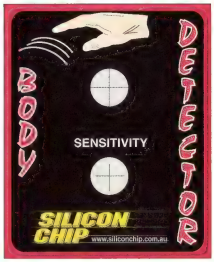
The Body Detector should now react when your hand approaches the sensor, from a distance of few centimetres. With careful adjustment, a distance of 20cm+ should easily be achieved.

All in all, it is sensible to calibrate the Body Detector so that it is sensitive enough to safely trigger, yet not so sensitive that it comes too close to its trigger threshold, which may lead to instability. Finally, adjust VR3 (turning this clockwise) to set the monostable and relay to the desired time period.

In use

A wide variety of metal sensors may be tried. Always be sure to make a secure connection between the circuit and the sensor.

Try different shapes and sizes of aluminium foil – also a grid made of aluminium foil. You may also experiment with larger objects such as a bicycle or a fridge door, which should serve quite well as sensors. In the case of very heavy metal items, a lighter sensor may be mounted on their surface, without any physical connection to the object itself, to far better effect.



Remember that the unit's sensor is also capable of picking up body presence through various materials – even through insulators such as glass.

Cascading

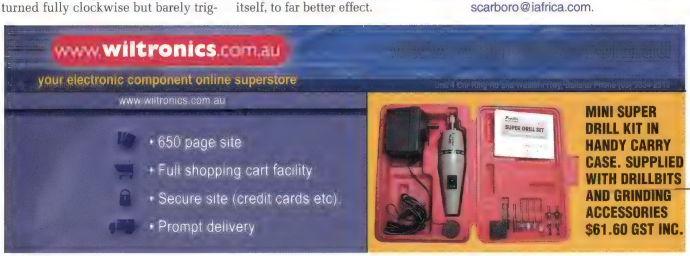
There are two parts to the circuit – the "Power Circuit" and the "Sensor Circuit" (see Fig.1). A few sensor circuits may be constructed (without the power circuit) and cascaded – that is, wired in parallel – with the main unit which contains the power circuit.

A three-conductor cable is required, connecting the +5V and 0V rails and the output of the sensor at point B (the junction of the .033µF capacitor, D2 and D3) to the same point on the main circuit board.

Each sensor would be individually adjustable for sensitivity.

Thus it would be possible to protect larger areas, or a greater number of items, than would be possible with a single "sensor" board. **SC**

*The author may be contacted at scarboro@iafrica.com.



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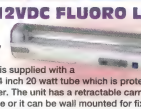

This attractive, high quality fluorescent light fitting is supplied with a standard 24 inch 20 watt tube which is protected by a clear acrylic cover. The unit has a retractable carry handle for portable use or it can be wall mounted for fixed installations. Operates from 12VDC & includes on/off switch. 95W x 75H x 680Lmm. 520mA. Cat. ST-3060

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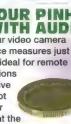

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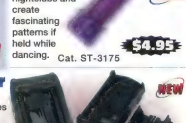

This microprocessor controlled charger is designed to quickly charge 3.6 & 7.2 volt Lithium-ion camcorder batteries in as little as 4 hours, (up to twice as fast as an ordinary charger) and keep them topped up between uses. It features precision end-of-charge voltage detection, 'top-off' trickle charge, defective battery detection and over charge protection. The charger is supplied with an AC adaptor for use at home and a cigarette lighter plug and cable for use in the car. Suitable for most lithium-ion camcorder batteries. Adaptors are included to accommodate batteries from the major manufacturers including Sony®, PANASONIC®,JVC®, CANON®, & SHARP®.
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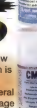

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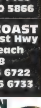

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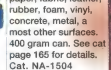

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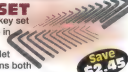

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SERVICEMAN'S LOG

What a way to make a living!

Hopefully, I must not be too far off retiring because the older I get, the less sense I make of it all. Not only are the faults getting trickier but you almost need a university degree to drive some of the latest on-screen menus.

I've just come back from reinstalling a Sony SLV-EZ111AZ/HM video for the Buntings in an old folks' home. The set is barely out of its egg, as it was sold just two months ago, and I originally installed it in their unit which has a UHF community antenna system.

With so many satellite stations transmitting now, it is very difficult to find a slot on the UHF band for a video, and even more so for Foxtel as well. In this instance, the default Ch36 or 37, as well as Ch50, had co-channel interference with another station (the village was positioned on top of a plateau), so eventually I found I had to use Ch69. I then managed to tune in all the stations reasonably, though Ch7 was poor and the Teletext had a lot of errors (being hard of hearing, they needed the subtitle service on page 801).

But this was a piece of cake compared to what was about to happen. Recently, the Buntings were moved into another unit and I had to reinstall it all over again.

Piece of gateau, you may think. Wrong!

Their new place used VHF channels 2, 7, 9 & 10, with only Ch28 on UHF. Everything retuned OK but the video was decidedly snowy – even on tape playback – whereas the TV reception was good.

I tried changing the VCR's output channel to various settings from one end of Band IV to the other end of Band V. I even made sure there was no receivable transmission on the channel selected by removing the antenna lead and connecting it to the video lead and checking for pure snow.

I then tried replacing the leads in case they were faulty – though if the reception on the TV off-air was good, I couldn't see how changing the leads could make any difference.

By now I was getting a little desperate and was suspecting a faulty RF modulator in the new video. I tried an AV lead and there was a big improvement all round on both playback and the off-air EE signal. And then, while playing a tape and swapping the RF lead to the video, I noticed that the picture was now excellent, with no snow at all.

Obviously, unplugging the RF lead did the trick. And that meant that there had to be something funny about the RF signal coming in from the community antenna system.

That's when it hit me – we now live in a digital era (something old analog types like me find hard to comprehend) and things are now very different. Somehow, the digital broadband energy of the VHF co-channels was affecting the RF modulator of the video.

Silly me for being so miserly – I had left my $10,000+ spectrum analyser back at the workshop along with my bank overdraft, mostly because I reckoned it would take me a thousand house calls to pay for it.

Anyway, the modern way, it turns out, to fix a very snowy picture is not to boost the signal but to attenuate it!

A 12dB attenuator in series with the video's RF input (antenna) socket improved the picture out of sight. Using the AV leads as well resulted in a picture that was as good as when the TV was connected directly to the antenna.

In case you're wondering, the Bunting's TV was also a Sony – in this case, an older model KV-G21S11 (BG-1S Chassis) – and the problem facing yours truly (and other TV service technicians) is the diverse ways various receivers behave when there are digital broadcasts.

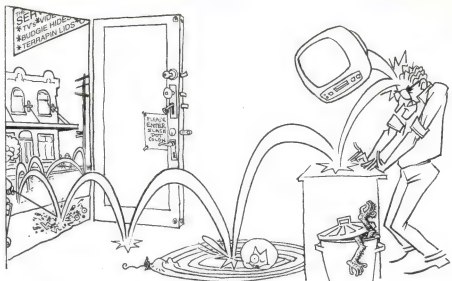
After all, why should this particular Sony set behave differently to other sets, especially as the only other signal on UHF being transmitted on that community aerial system was Ch28 (hardly an adjacent channel). I fear we are in for a lot of this before it all settles down.

Anyway, the Buntings were happy with the reception but couldn't understand why it had taken me so long.

A Teac bounces in

A few months ago, I told you about a Teac Televideo MV1480MkII that I serviced. Well, it came bouncing back with a tag that said "No sound – customer not happy".

Last time, it had an intermittent open circuit loudspeaker, so I figured this had to be an easy repair. The only problem was, when I got the back off and checked the new speaker it was fine. Not only that but when playing a tape, the sound was fine too. It was only in the EE mode (tuner) that I was getting absolutely no sound at all and that included the record mode. Fortunately, I had the service manual and felt that although this was a little more complex, it wasn't insurmountable.



If you can recall the last article, the set turned out to have a faulty surface-mounted IF transistor, so I thought that the IF module would be a good place to start with this repair.

When you look at the back of this set, you could die of despair for lack of access. Luckily, when you get as intimate as I have (unfortunately) been with this one, you will find that it is not that bad – not brilliant but not too bad!

Undoing four screws lets you remove the tuner board (MCA), as well as the colour decoder, and turn it on its side to gain access to the underneath. That done, I used an audio amplifier with a test probe to establish that I did indeed have sound output from pin 7 of the IF module. This went via the AV input (which also didn't give any sound) to plug CL-4 pin 1 on the MCV-C board.

I traced the sound to R227 (27kΩ) and then C227 (0.47µF), before it disappeared altogether on pin 11 of IC201 (BA7767AS). This IC is some sort of custom audio record/playback control chip. I checked and replaced both R227 and C227 and also C217 but drew a blank. I then checked QR201, a digital audio muting transistor, but it too was OK.

Next, I shorted the base and emitter pins of QR201 and suddenly the sound was back. Ah ha! – the audio mute line is ON in the EE mode, my brain jumping quick as a flash to the bleeding obvious. I quickly checked the audio mute line and it measured 2.5V, so I now had to find out what was causing this.

Unfortunately, the next part took a lot of time and effort, especially as access was now appalling, but I had to trace where the audio muting came from. The circuit is also confusing, as it shows two separate paths in parallel from pin 18 of IC201. One is drawn via plug CL-10 pin 1 to pin 47 of IC501 (microprocessor 14D0899) on the MCV-B board. The other is from CL-4 pin 8 to CL-5 pin 3 and back to the same pin on the microprocessor (ie, pin 47).

On careful examination, I found that the former route was not connected, as links J519 and J503 were not fitted on the MCV-B. I can only assume that this was for different model options and function variations.

OK, I now knew for sure what was causing the problem but fixing it was another matter. After already spending a lot of time on this job, I was severely tempted to just leave it with CL-4 pin 8 unsoldered – after all, everything worked.

However, unsolved questions like this really bug me so I set about finding what it was that was causing the audio mute line to go high.

Items Covered This Month

- Sony SLV-EZ111AZ/HM VCR.
- Teac MV1480MkII Televideo.
- Panasonic TC-21510A TV set.
- Panasonic TC-21SV10A Televideo.

First, I checked every part of the rail, especially D402 which comes off the D-V line (whatever that is). Anyway, unsoldering this diode made no difference. It looked as though something was telling the microprocessor to mute the line but what?

I tried all sorts of things and even phoned Teac technical support but no-one could give me any ideas.

I finally had a bit of luck when I tried to tune in a signal generator. The preset search would tune in all the stations OK but wouldn't stop on any of them. This was a major clue, so I had to investigate how the self-seeking tuning system worked. This wasn't easy because, as you will have gathered by now, there is no glossary on the abbreviations used in this set for each of the lines.

Q704 controls the 0-33V feed to pin 4 (VC) of the tuner and the base of this transistor is controlled by T-DAC via CL-6 pin 3 from pin 60 of the microprocessor.

Once again, I hit a brick wall. I had no way of knowing what inputs to the microprocessor were controlling its outputs.

However, this time I was luckier in guessing that the SD line on pin 46 was the "Tuner Video Signal Sync Signal Output" which comes from IC703 LA7210 pin 10. The video signal goes into pin 6 and in the tuner search mode gives an output from its comparator to the microprocessor which locks in the stations and also controls the AFT up/down lines from IC502.

Though all the DC voltages were correct on IC703, there was no signal output from pin 10. I changed C713, C716 and C714 but it was actually the IC that was the cause of the problem. A new one fixed the self-seeking tuning as well as the audio muting and the sound was restored.

Panasonic MX-3 chassis

Just recently, I seem to have done the Panasonic MX-3 chassis to death, which is not what you would expect these days from a quality 5-year old product.

The first one was a TC-21510A that was "dead and whining" (who wouldn't be?). This luckily turned out to be just C805 and C825, two small electros that had dried up in the power supply.

The next one was worse. The same electros caused Q805 and R826 to destruct, as well as Q803 (the protection relay driver) and D835 (the 56V protection zener on the 42V rail). IC801 (an SE090 IC regulator) and optocoupler D820 (P82501) had also failed.

The third one of the same model was even worse. It came with the complaint "Dead and Pulsating" (surely an oxymoron?). This set had already been around a variety of different technicians before me so I felt like a bunny in taking it on.

It turned out that C805, C825, Q805, Q803 and D835 had already been replaced and we had 42V, 22V, 5V and 90V rails but that was all. Most people would say they could get a TV to work with that much but not on this model. The power supply is unusual (it's similar to the supply in some NEC sets) and is integrated with the line output stage. It's also all at live mains potential; ie, it's *hot!*

The secondaries are taken off via T802 and the flyback transformer T501. The only other transformer which separates the COLD from the HOT is the horizontal driver T566 – even the deflection coils are at HOT (horizontal) and COLD (vertical) levels! Because of this, precautions have to be taken if you don't want to get zapped.

Anyway, this particular set had no line drive, or rather, very little. There was enough at first to think you had some but a few checks with the CRO soon showed that Q565, the horizontal driver, just wasn't being driven hard enough. As a result, I spent some time trying to find out why there was insufficient line drive.

Eventually, I concluded that the problem involved either the jungle IC (IC601, AN5192K) or its associated circuits. First, I had to check if the voltages coming into the IC on pins 14 (9V), 23 (5V) and 47 (5V) were OK. They weren't because they are all derived from the line output stage via D511 (20V) and via IC805, IC806 and IC807. The horizontal oscillator is started by the 22V rail going through R553 pin 51 of IC501 (HOR-REG). The 6.6V was present and the oscillator crystal (X554) was on frequency.

Understanding the circuit and working out what was supposed to happen and what wasn't had taken a lot of time. By now I was fairly convinced that the problem was insufficient line drive from the jungle IC and so I fitted a new one.

This fixed the set – well, nearly. I now had sound and picture but no OSD (On Screen Display) and the set cut out after about five minutes.

I fixed the cutting out fault first when I accidentally burned myself on IC802, a 7805 5V regulator that was getting extremely hot. Freezing it stopped the set going off but finding the cause of the problem is a story in itself.

The IC still supplied 5V when it got hot and although the rail didn't measure short circuit, it was obviously low impedance. This 5V rail mainly supplies the microprocessor, the EEPROM and the power LED, all of which were working.

So there I was, suspecting and substituting components on the 5V rail but to no avail. I was about to change the microprocessor because of the OSD fault when I noticed a small whiff of

smoke appearing from a very small black component next to IC1101. This black component turned out to be what was left of D1101, a MA4056L 5.6V zener diode.

Replacing this reduced the stress on IC802 and it no longer got very hot. This stopped the set from cutting out so I moved on to the OSD problem.

The red, green and blue signals normally come out of pins 33, 32 & 29 of the microprocessor but these were absent. The other signals I was looking for were the blanking pulses on pin 31 and the horizontal sync pulses on pin 30. The latter were also missing and are normally applied via Q1135 from pin 6 of the flyback transformer. When I traced them with the CRO, the pulses stopped at Q1135 and replacing this 2SC945 transistor restored the on-screen display.

Two televideos

I had two Panasonic TC-21SV10A Televideos (MX-3V chassis) in quick succession, with very similar faults. The first came from a school and, among other things, had suffered a cracked cabinet (apparently, it had fallen onto the floor). Both sets also had video tapes stuck inside them which couldn't be ejected.

The VCR chassis employs a K-mechanism and is tucked under the TV chassis and power supply. Invariably, by the time you get the chassis out, remove its covers, reconnect the four leads (E23, E24, E26 & E27) and switch on, the resultant jolting has freed the mechanism and the cassette ejects properly. And no matter how you try it, it is almost impossible to recreate the fault – unless of course, you send it back to the customer when it will do it immediately!

Fortunately, I am pretty familiar with the K-mecha video deck and the most likely culprits are the loading motor and the mode select switch. The deck is removed by undoing four screws at the bottom and three at on top and then unplugging all the connectors. The loading motor frame can then be removed by undoing one screw and two clips, after which the motor can be unclipped from its support frame.

The worm gear (DG0866) and the pulley bush VDP1434 (in particular) have to be replaced – the latter cracks and then slips on the motor shaft.

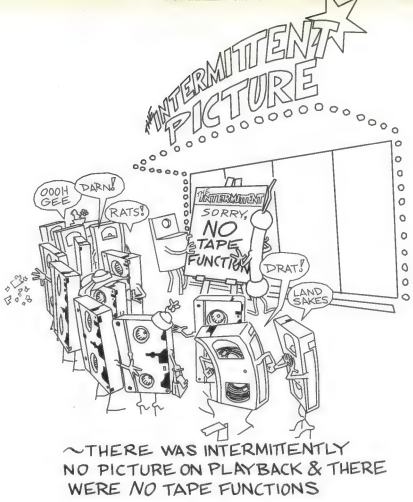
The mode select switch (VSS0365) is held on by one screw and several clips. It is important to replace it with the mark on the mode switch and the notch in the frame or the arrows pointing at SE (4.30), with the screw located at N (12.00).

In this particular case, after doing all this and reassembling it, I found that there was intermittently no picture on playback and there were no tape functions. When I removed it the second time, I eventually found a 7cm-long hairline fracture in the lower main board near IC2502. I repaired all the cracks in the board pattern and reassembled it again but I still wasn't out of the woods as it was stuck in Timer Record Mode, with the orange LED on.

Setting the clock fixed this problem but I also checked the TV and video by going into the service mode or market mode and self-check modes. To do this, you use the remote control to select MENU, FEATURES, OFF TIMER O and then set the time to either 30, 60, 90 or AUTO minutes.

You then simultaneously press RECALL on the remote and volume down on the set. There are four CHK settings to adjust all the controls. POWER OFF returns it to Normal Mode.

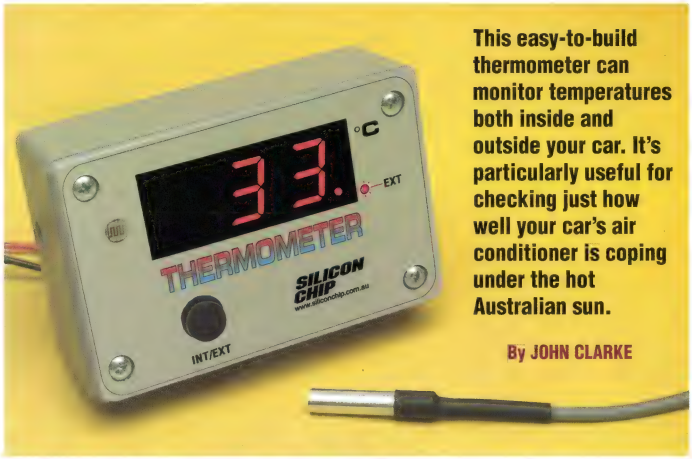
The self-check function is enabled by simultaneously holding down the right arrow on the remote (in the TIMER menu) with the volume down button on the set. This brings up a screen with DATA for the TV and VIDEO which is compared with a list in the service manual to indicate faults. You then switch the POWER OFF to resume Normal Mode.



Bizarre fault

As mentioned, the second TC-21SV10M also came in with a tape that wouldn't eject. Performing all the above fixed that except that it had a bizarre fault. Whenever there was a snowy picture, either in EE Tuner mode, or in video playback, the screen would go intensely white with a black horizontal line in the centre.

Normally, the set is designed to display a blue background screen if selected in the FEATURE menu but this wasn't happening. Strangely, after going through the Market Mode and self checking modes, the fault completely cleared itself. Just why it did this I don't know as no fault was ever reported in any of the menu pages. SC



This easy-to-build thermometer can monitor temperatures both inside and outside your car. It's particularly useful for checking just how well your car's air conditioner is coping under the hot Australian sun.

By JOHN CLARKE

Automotive Thermometer

Keep tabs on in-car temperatures

AS WE ALL KNOW, the temperature inside a car can rise dramatically during the summer months, particularly if the car is left out in the midday sun. In fact, inside temperatures can quickly reach 60°C or more. This is because a car makes a good glasshouse that collects and traps solar radiation.

Because it can monitor both inside and outside temperatures, this thermometer will quickly show you how much hotter it is inside the cabin than outside. And by temporarily positioning the inside sensor near the air-conditioner vents, you can quickly check on the effectiveness of the air-conditioning.

Conversely, during the winter months, our new thermometer will reveal how cold it is outside and just how effective the heater is in warming the interior. Outside temperatures of 0°C and below can indicate possible icy conditions on the road.

But perhaps the main use of an in-car thermometer is to provide valuable feedback when it comes to setting air-conditioning or heater controls. Generally, you will want to maintain a constant temperature of about 23°C with plenty of fresh air. Obviously, a comfortable environment contributes greatly to road safety. A hot and stuffy cabin greatly increases driver irritation and can also lead to

drowsiness. Accidents due to drivers falling asleep at the wheel occur all too frequently.

Main features

Many aftermarket thermometers use liquid crystal displays (LCDs) but most of these are not suitable for automotive use. While the sensors may be rated to read temperatures up to say 100°C, the LCD itself may not be rated for the high cabin temperatures reached in a car during summer.

After a hot day, you can be left with a thermometer which just shows a black display and this effect isn't reversible. So don't be tempted to use these thermometers in a car unless they are specifically rated for high ambient temperatures.

Our design gets around this problem by using LED displays. These are unaffected by high temperatures and give a better display at night. And by using LED displays, we've been able to design an instrument that matches the appearance of our previous car projects – ie, the Speed Alarm (Nov. 99); the Digital Voltmeter (Feb. 2000); the Digital Tacho (April 2000); and the Fuel Mixture Display (Sept. 2000).

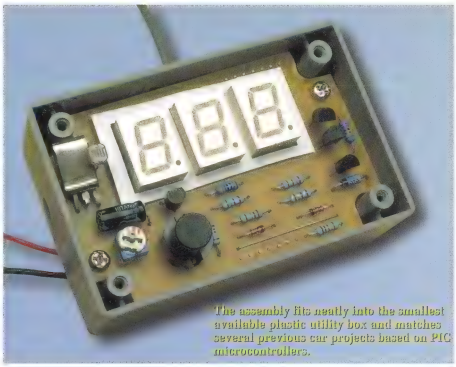
Naturally, we've included an automatic dimming feature, so that the display brightness varies according to the ambient light. That way, the displays are nice and bright for daytime viewing but are dimmed at night so that they don't become too distracting.

Our previous instruments were all based on a PIC16F84 microcontroller which kept the parts count (and the cost) down. That's right, you've guessed it! – our new Automotive Thermometer is also based on a PIC16F84 microcontroller.

It's the bits that "hang off" the microcontroller and the software embedded into it that makes each design perform its intended role.

Our new Automotive Thermometer is also quite small and is very accurate because it uses precision sensors (LM335) to monitor the inside and outside temperatures. These sensors are typically accurate to within 1°C over the entire -40°C to 125°C temperature range.

It's also a easy to use, which is the way it should be for a car project. On power up, the display initially shows three dashes while the unit is making the temperature measurements. The display then shows either the inside or outside temperature, depending on the last selection made.



The assembly fits neatly into the smallest available plastic utility box and matches several previous car projects based on PIC microcontrollers.

The single pushbutton switch on the front panel lets you toggle between the internal and external temperature readings. How do you know which is which? Simple – the righthand decimal point lights when the external temperature is being displayed.

Calibration – it's a snack

A feature of the design is that the unit is self-calibrating. First, both sensors are cooled to 0°C in a solution, as described later. The unit is then switched on with the Display switch held down. When the switch is released, the display will show "CAL" and the thermometer then automatically determines the calibration required for each temperature sensor.

That's it – you don't have to do anything else!

Main Features

- Measures inside and outside air temperatures
- -40°C to +125°C range
- Measurement accuracy better than 1°C
- Resolution of 1°C
- Easy calibration
- Display dimming

Once calibration is complete, the display shows the current temperature – ie, 0°C for both sensors. If the sensors are then removed from the 0°C solution, the display then shows the individual temperatures measured by each sensor.

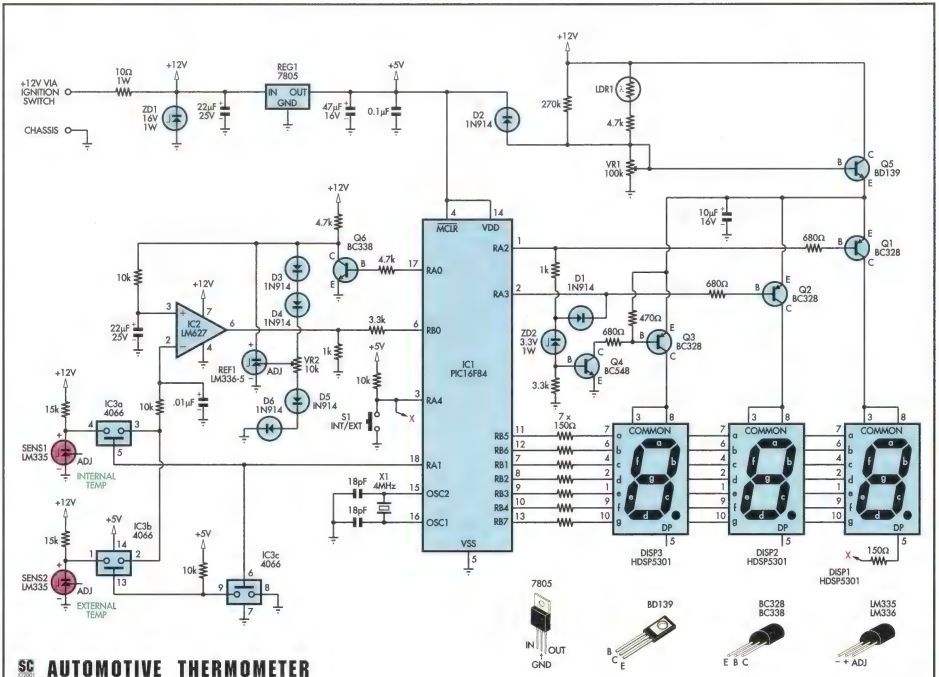
Circuit details

OK, let's now take a look at the circuit – see Fig.1. It's dominated by IC1 which is the PIC16F84 microcontroller. It accepts inputs from the two temperature sensors (SENS1 & SENS2) via a signal conditioning circuit (IC2) and drives the 7-segment LED displays (DISP1-DISP3).

Most of the complexity of this circuit is hidden inside the PIC microcontroller and its internal program. That's the beauty of using a microcontroller – we can easily do complicated things with a very low parts count.

Temperature sensors SENS1 and SENS2 respectively monitor the internal and external temperatures. These devices are each supplied with current from the nominal 12V supply via a 15kΩ resistor. Assuming a supply of 13.8V (normal in most cars), this gives about 700µA of current through each device at 25°C.

As the temperature rises, the voltage across the sensor rises in a linear fashion at 10mV/°C. However, the current through the sensors remains rea-



SC AUTOMOTIVE THERMOMETER

Fig.1 (left): the PIC microcontroller (IC1) processes the input signals from the temperature sensors and drives the 7-segment LED displays. Q6, IC2 and REF1 work with IC1 to provide the A/D conversion, while LDR1 and Q5 automatically vary the display brightness, so that they don't appear too bright at night.

sonably constant. For example, at 125°C, the nominal 3.98V across the sensor reduces the sensor current to 650μA, while at -40°C, the 2.33V across the sensor increases the current to 760μA.

So the current through the sensors varies by just 110μA over a 165°C temperature range. This effectively prevents any change in sensor voltage (and thus false readings) due to current changes.

Also, the self-heating of the sensors due to power dissipation is as low as practicable but this effect does contribute to inaccuracies in the temperature reading. However, to a large extent, the self-heating effect is cancelled out when the thermometer unit is calibrated.

IC1's RA1 output is used to select between the two sensors. It works like this: when RA1 is high, pin 5 of CMOS switch IC3a is pulled high and so IC3a is closed. As a result, the voltage across SENS1 is fed through to pin 3 of IC3a and applied to pin 2 (inverting) of op amp IC2 via a 10kΩ resistor.

At the same time, CMOS switch IC3c also closes and this pulls pin 13 of IC3b to ground. This means that IC3b is open and so SENS2 is effectively out of circuit.

Conversely, SENS2 is selected by taking RA1 low. When that happens, IC3a & IC3c both open and pin 13 of IC3b is pulled high via a 10kΩ resistor connected to the +5V rail. This closes IC3b and so the voltage across SENS2 is now applied to pin 2 of IC2 via the 10kΩ resistor.

So when RA1 is high, SENS1 is selected and when RA1 is low, SENS2 is selected. The 10kΩ resistor and .01μF capacitor on pin 2 of IC2 filter out any glitches due to the operation of the CMOS switches.

A/D converter

Op amp IC2 works in conjunction with the RA0 output of IC1 to form an A/D (analog-to-digital) converter. This converts the analog voltage applied to pin 2 of IC2 into an 11-bit digital value which is then used to drive the LED displays. Let's see how this works.

IC2 is an LM627 precision op amp and is wired here as a comparator. This device has the very low input offset and input current specifications necessary to obtain the 2.44mV resolution required for an 11-bit A/D converter. By contrast, standard op amps with 10mV offset voltages cannot be used here because they would introduce significant errors during conversion.

In operation, the A/D converter relies on IC1 to ensure that the voltage applied to pin 3 of IC2 matches the sensor voltage applied to pin 2. It does this by producing a pulse width modulated signal (PWM) at its RA0 output which is then stabilised and filtered to produce a steady voltage.

For example, if the RA0 output has a 50% duty cycle, the filtered voltage

Parts List

1 display PC board, code 05110011, 79 x 50mm
1 processor PC board, code 05110012, 79 x 50mm
1 front panel label, 80 x 53mm
1 plastic case utility case, 83 x 54 x 30mm
1 red Perspex or acrylic sheet, 18 x 46mm
1 4MHz parallel resonant crystal (X1)
1 LDR (light resistance <1kΩ, dark resistance >1MΩ) (LDR1)
4 PC stakes
1 100kΩ horizontal trimpot (VR1)
1 10kΩ horizontal trimpot (VR2)
1 5mm x 20mm piece of 0.5mm brass or 1mm aluminium for heatsink
2 7-way pin head launchers
1 2-way pin head launcher
1 3-way pin head launcher
2 DIP-14 low-cost IC sockets with wiper contacts (cut for 2 x 7-way single in line socket, 1 x 2-way single in line socket and 1 x 3-way SIL socket)
1 PC-mount click action push-on switch (S1)
1 9mm tapped brass spacer
1 6mm untapped spacer
2 6mm tapped spacers
2 M3 x 6mm countersunk screws or Nylon cheesehead
2 M3 plastic washers 1mm thick or 1 M3 plastic washer 2mm thick
2 M3 x 15mm brass screws
1 2m length of red automotive wire
1 2m length of green automotive wire
1 4m length of shielded cable
1 500mm length of 0.8mm tinned copper wire

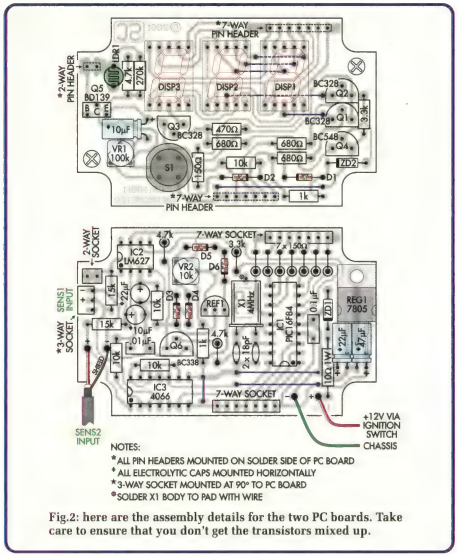
Semiconductors
1 PIC16F84P microprocessor programmed with TEMP.HEX program (IC1)
1 LM627N op amp (IC2)
1 4066 quad CMOS switch (IC3)
1 7805 1A 3-terminal regulator (REG1)
2 LM335Z temperature sensors (SENS1,SENS2)
1 LM336Z-5 5V reference (REF1) (Altronics Z 0558)
3 BC328 PNP transistors (Q1-Q3)
1 BC548 NPN transistor (Q4)
1 BC338 NPN transistors (Q6)
1 BD139 NPN transistor (Q5)
3 HDSP5301, BS-A536RW common anode 7-segment LED displays (DISP1-DISP3)
1 16V 1W zener diode (ZD1)
1 3.3V 1W zener diode (ZD2)
6 1N914, 1N4148 diodes (D1-D6)

Capacitors
1 47μF16VW PC electrolytic
1 22μF 35VW PC electrolytic
2 10μF 16VW PC electrolytic
1 0.1μF MKT polyester
1 .01μF MKT polyester
2 18pF ceramic

Resistors (0.25W 1%)

1 270kΩ	1 1kΩ
2 15kΩ	3 680Ω
4 10kΩ	1 470Ω
3 4.7kΩ	8 150Ω
1 3.3kΩ	1 10Ω 1W

Miscellaneous
Automotive connectors, heatshrink tubing or 5mm ID metal tubing, cable ties, etc.



NOTES:
* ALL PIN HEADERS MOUNTED ON SOLDER SIDE OF PC BOARD
* ALL ELECTROLYTIC CAPS MOUNTED HORIZONTALLY
* 3-WAY SOCKET MOUNTED AT 90° TO PC BOARD
* SOLDER X1 BODY TO PAD WITH WIRE

Fig.2: here are the assembly details for the two PC boards. Take care to ensure that you don't get the transistors mixed up.

will be 50% of the peak square-wave voltage. The accuracy depends on the precision of the PWM signal (set by a timer based on a crystal oscillator) and on the peak voltage remaining constant with temperature.

An LM336Z-5 3-terminal reference (REF1) is used to set the peak voltage to this required precision. This device is supplied with current from the +12V rail via a 4.7kΩ resistor and is adjusted using trimpot VR2 to produce a fixed 5V output. Diodes D3-D6 are wired in series with VR1 (two on either side) and provide temperature compensation for this adjustment.

As shown on Fig.1, RA0 drives the base of transistor Q6. Each time RA0 goes high, Q6 turns and so the voltage across REF1 drops to a few millivolts. Conversely, when RA0 goes low, Q6 is off and so the REF1 voltage (+5V) is present on Q6's collector.

As a result, a PWM signal appears at Q6's collector which has a precise +5V amplitude. This PWM signal is filtered using a 10kΩ resistor and a 22µF capacitor to produce a steady DC voltage which is applied to pin 3 of IC2.

In greater detail, the PWM signal from RA0 has a fixed frequency of 1960Hz but operates with a duty cycle ranging from about 40% (ie, high for 40% of the time) to 80%. If the duty cycle is 50%, then the filtered voltage on pin 3 of IC2 is 50% of 5V, or 2.5V. Other voltages are obtained by using different duty cycles.

The A/D conversion process uses a "successive approximation" technique. This all takes place inside the PIC microcontroller, with the duty cycle for each successive approximation controlled by the software.

Following the conversion, the binary number is stored in an 11-bit register in IC1 and this must be converted to a decimal value before it can be shown on the 3-digit LED display. Once again, this takes place inside the PIC microcontroller.

Note that the A/D conversion of the temperature sensor outputs is done on a continuous basis – ie, SENS1 is measured, then SENS2 is measured and then the process is repeated. The actual conversion time is a fairly slow, taking around seven seconds, but since the sensors are also slow responding, a fast conversion isn't important.

The only time it does become noticeable is at power up, since the display will show dashes until the first conversion is completed. That's hardly a problem.

To digress briefly, note that IC2 is powered from a 12V supply which means that its output can switch higher than the 5V supply to IC1. For this reason, pin 6 of IC2 drives RB0 of IC1 via a 3.3kΩ current limiting resistor to prevent damage to the internal protection diodes on pin 6 of IC1.

These internal protection diodes clamp the signal input to RB0 to a maximum of 5.6V.

Table 1: Capacitor Codes

Value	IEC Code	EIA Code
0.1µF	100n	104
.01µF	10n	103
18pF	18p	18

Driving the displays

The 7-segment display data from IC1 appears at outputs RB1-RB7. These directly drive the display segments via 150Ω current-limiting resistors, while the RA2 & RA3 outputs drive the individual displays in multiplex fashion via switching transistors Q1-Q4.

As shown, the corresponding display segments are all tied together, while the common anode terminals are driven by the switching transistors. In this case, the RA2 & RA3 outputs drive transistors Q1 & Q2 directly via 680Ω base resistors to control displays DISP1 & DISP2.

What happens is that IC1 switches its RA2 & RA3 lines low in sequence to control the switching transistors. For example, when RA2 goes low, transistor Q1 turns on and applies power to the common anode connection of DISP1. Any low outputs on RB1-RB7 will thus light the corresponding seg-

ments of that display.

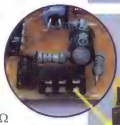
After this display has been lit for a short time, RA2 is switched high and DISP1 turns off. The 7-segment display data on RB1-RB7 is then updated, after which RA3 is switched low to drive Q2 and display DISP2. RA3 is then switched high a short time later to turn DISP2 off and give DISP3 its turn.

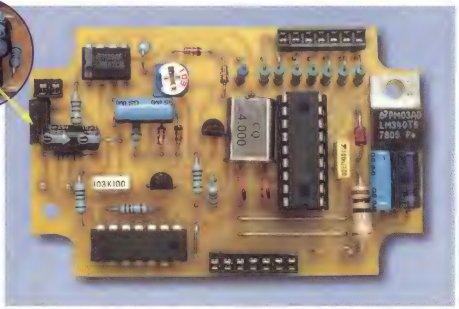
Display DISP3 is driven whenever RA2 and RA3 are both high at the same time. It works like this: if RA2 and RA3 are both high, diode D1 is reverse biased and so Q4 turns on due to base current flowing through the associated 1kΩ resistor and zener diode ZD2. Q4 in turn drives Q3 via a 680Ω base resistor and so Q3 applies power to DISP3.

DISP3 is subsequently switched off when either RA2 or RA3 goes low. For example, if RA2 goes low, there is no base drive to Q4 and so both Q4 and Q3 are off (note: when Q4 turns off, the 470Ω resistor pulls the base of Q3 high).

On the other hand, if RA3 goes low, D1 becomes forward biased and pulls ZD2's cathode low. This turns Q4 off and so Q3 also turns off, as before.

The 3.3kΩ resistor on Q4's base is there to ensure it turns fully off. If this were not done, DISP3 would show a faint replica of the lit segments on DISP2.





The display board (top) carries the three 7-segment LED displays and the LDR. It plugs directly into the header sockets on the microcontroller board (above), thus eliminating messy external wiring connections between the two.

Display dimming

Light dependent resistor LDR1, transistor Q5 and trimpot VR1 control the display dimming. In bright light, LDR1's resistance is low and thus Q5's base voltage is pulled high and is clamped via D2 to about 5.6V.

Q5 is wired as an emitter follower. This means that its emitter will be at +5V and so the LED displays will operate at full brightness.

In low light conditions, the LDR resistance increases so that it now forms a voltage divider with VR1. This

Table 2: Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	270kΩ	red violet yellow brown	red violet black orange brown
2	15kΩ	brown green orange brown	brown green black red brown
4	10kΩ	brown black orange brown	brown black black red brown
3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
1	3.3kΩ	orange orange red brown	orange orange black brown brown
1	1kΩ	brown black red brown	brown black black brown brown
3	680Ω	blue grey brown brown	blue grey black black brown
1	470Ω	yellow violet brown brown	yellow violet black black brown
8	150Ω	brown green brown brown	brown green black black brown
1	10Ω	brown black black brown	brown black black gold brown

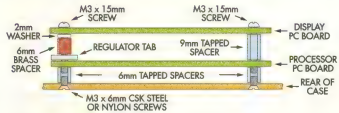


Fig.3: this diagram shows how the two boards are stacked together and secured using screws, nuts and brass spacers. Notice that the righthand spacer is 9mm long, while the lefthand one is just 6mm long.

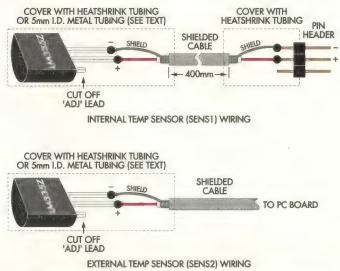


Fig.4: here's how to wire up the two temperature sensors. Note that the internal sensor plugs into a matching 3-way header socket on the microcontroller board.

lowers the base voltage applied to Q5, which reduces the voltage on it emitter (and hence the supply to the displays) accordingly. As a result, the displays operate with reduced brightness.

VR1 is used to set the minimum display brightness.

Display switch

The display switch S1 performs two functions: (1) it toggles the readings between the internal and external sensors; and (2) it's used to initiate the calibration procedure (by holding it down during power-up).

This switch is connected directly to the RA4 pin of IC1. This input is normally held high by a 10kΩ resistor but is pulled low each time S1 is pressed. This is detected by IC1 and processed by the software accordingly.

The RA4 pin also acts as an output which drives the righthand decimal point for DISP1 when the external temperature is being displayed. In practice, if this decimal point is to be lit, it is only necessary for the RA4 line to be low when DISP1 is selected. If either the DISP2 and DISP3 displays are lit, RA4 is free to monitor S1.

This is all done under software control, with the decimal point in DISP1 only turning on when SENS2 (the external sensor) is selected.

The display is also blanked while the display switch is pressed, so that the decimal point does not light due to the low on RA4. This blanking is achieved by setting all the RB1-RB7 outputs high on the display and by ensuring that RA1 remains high so that Q1 remains off.

Clock signals

Clock signals for IC1 are provided by an internal oscillator which operates in conjunction with 4MHz crystal X1 and two 18pF capacitors. The two capacitors are there to provide the correct loading for the crystal, to ensure that the oscillator starts reliably.

The crystal frequency is divided down internally to produce separate clock signals for the microcontroller operation and for display multiplexing.

Power

Power for the circuit is derived from the vehicle's battery via the ignition switch. A 10Ω 1W resistor and 22μF capacitor decouple this 12V supply, while zener diode ZD1 provides transient protection – ie, it limits any spike voltage to 16V – and also provides reverse polarity protection.

The decoupled supply rail is then fed to REG1 which provides a regulated +5V output and this in turn is decoupled using 47μF and 0.1μF capacitors.

The +5V rail is used to power IC1 & IC3, while the decoupled 12V rail supplies the rest of the circuitry, including IC2 the sensors and the displays.

Construction

You don't have to understand how the software works or do any programming to build this project. Instead, it's all programmed into the PIC chip. You just buy the preprogrammed chip and "plug" it in and it all works.

All the parts for the Automotive Thermometer are mounted on two PC boards: a display board coded 05110011 and a processor board coded 05110012. Both boards measure 79 x 50mm and are stacked together using pin headers and cut-down IC sockets.

These pin headers and modified IC sockets make all the necessary connections between the two PC boards. The only wiring you have to run involves the external power supply connections and the sensor leads.

Fig.2 shows the assembly details for the two PC boards. As usual, check your PC boards for defects and undrilled holes before installing any of the parts. In addition, the corners of each board must be shaped as shown in Fig.2; so that they clear the mounting pillars in the case.

You can start the assembly by building the processor board. Install the wire links first, then install the resistors using Table 2 as a guide to the colour codes. It's also a good idea to measure each resistor using a digital

multimeter, as some of the colours can be difficult to read.

Note that the seven 150Ω resistors at top right are mounted end-on, as are the two 4.7kΩ resistors and the 3.3kΩ resistor.

The horizontal trimpot (VR2) can be installed next, followed by a socket to accept IC1 (don't install the IC yet). This done, install IC2 & IC3, taking care to ensure that both are correctly oriented.

Next, install zener diodes ZD1 & ZD2, diodes D1-D6, transistor Q6 and the voltage reference (REF1). Regulator REG1 can then go in. This is installed with its metal tab flat against the PC board and its leads bent at rightangles to pass through their respective mounting holes. Make sure that the hole in the metal tab lines up correctly with its matching hole on the PC board.

The capacitors can now all be installed as shown, making sure that the electrolytics are mounted with the correct polarity. Note that the electrolytics must all be mounted with their leads bent at right angles, so that they lie parallel with the PC board (see photo). In particular, note that two of these capacitors lie over the regulator's leads.

Crystal X1 also mounts horizontally on the PC board. It is secured by soldering a short length of tinned copper wire between its metal case and a PC pad immediately to the right of D6.

Finally, you can complete the processor board assembly by fitting PC stakes to the external wiring points and installing the in-line sockets. These in-line sockets are cut down from 14-pin IC sockets using either a sharp knife or a fine-toothed hacksaw. You will need to cut down two 7-way sockets, a 3-way socket and a 2-way socket.

Clean up the rough edges with a file before installing them on the PC board.

Note that the 3-way strip mounts sideways in the SENS1 position, which means that you have to bend its leads at right angles before installing it on the board. A dob of superglue can be used to hold it in place.

Display board assembly

Now for the display board assembly. Install the six wire links and the resistors first, then install the three 7-segment LED displays. This done, install the PC stakes, transistors, diodes and trimpot VR1. Take care with the transistors: Q1-Q3 are all BC328s, Q4 is a BC548 and Q6 is a BC338.

Transistor Q5 mounts with its leads bent over so that its metal side faces upwards – see photo. It must be fitted with a small heatsink to assist in its cooling. We used a piece of 5 x 20mm brass bent over in the middle to form a spring-loaded clip. This was then slid over the body of the transistor.

Switch S1 can now be installed, making sure that the flat side is oriented as shown. This done, install the electrolytic capacitor and the LDR. The LDR should be mounted so that its top face is about 3mm above the displays. Make sure that its leads do not short against Q5's clip-on heatsink.

Finally, complete the display board assembly by fitting the pin headers. These are installed from the copper side of the board with their leads just protruding above the top surface. You will need a fine-tipped soldering iron to solder them to the copper pads on the PC board. It will also be necessary to slide the plastic spacers along the leads to allow room for soldering, af-

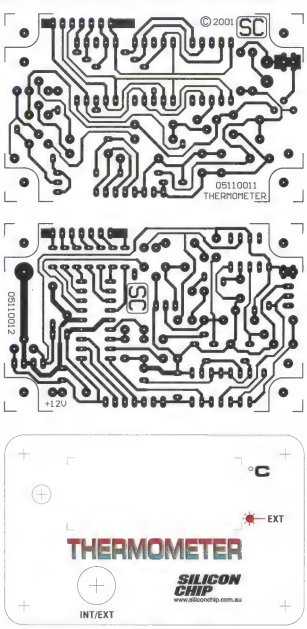
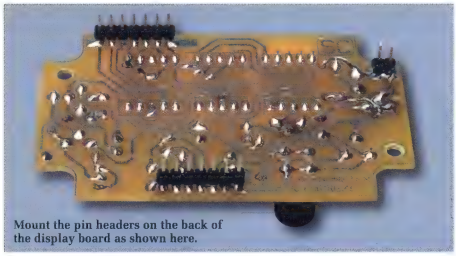
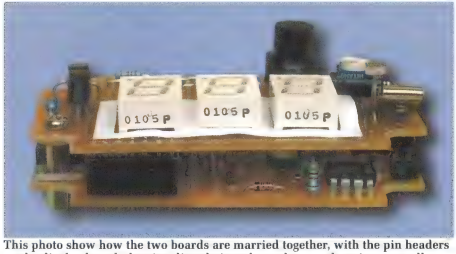


Fig.5: here are the full-size etching patterns for the two PC boards (top) and the front panel artwork.



Mount the pin headers on the back of the display board as shown here.



This photo show how the two boards are married together, with the pin headers on the display board plugging directly into the sockets on the microcontroller board – see Fig.3.

ter which the spacers can be pushed back down again.

Final assembly

Work can now begin on the plastic case. First, remove the integral side pillars with a sharp chisel and slide the processor PC board in place. Check that it doesn't foul the corner pillars.

Next, drill the two mounting holes in the base of the case for the PC board – one aligned with the metal tab hole of the regulator and the other to the above left of IC3. These holes should be countersunk on the outside of the case to suit the screws.

A hole is also required in one side of the case directly opposite the SENS1 socket. This hole is drilled 9mm up from the base of the case. You will also have to drill holes in the base of the case for the two power leads and the SENS2 lead (these should be drilled opposite their respective mounting points).

The display board can now be plugged into the processor board and the assembly secured as shown in Fig.3. Be sure to use a plastic washer in the location shown. Once it's all together, check that none of the leads on the display PC board interfere with any of the parts on the processor PC board. Some of the pigtails on the display PC board may have to be trimmed to avoid this.

The front panel artwork can now be used as a template for marking out and drilling the front panel. You will need to drill holes to make the display cutout, plus holes for the pushbutton switch and the LDR.

The main display cutout is made by first drilling a series of small holes around the inside perimeter, then knocking out the centre piece and filing the job to a smooth finish. Make the cutout so that the red Perspex (or acrylic) window is a tight fit.

A few spots of superglue along the inside edges can be used to make sure the window stays in place.

Testing

It is best to check the power supply before installing the microcontroller (IC1) in its socket.

To do this, unplug the display board and connect automotive cable to the +12V and GND inputs. Apply power and use a multimeter to check that there is +5V on pins 4 & 14 of IC1's socket, using the metal tab of REG1 for the negative (ground) connection.

If this is OK, connect the positive lead of the multimeter to the collector of Q6 (or the anode of D3) and adjust VR2 for a reading of 5V. This sets REF1 correctly so that it will deliver 5V when Q6 is off and have minimal drift with temperature.

Once this has been done, disconnect the power and install IC1, making sure it is oriented correctly. Now plug the display board back in and reapply power – the display should light and should show three dashes (---) for about six seconds. It should then show the current (uncalibrated) temperature.

You can test the dimming feature by holding your finger over the LDR. Adjust VR1 until the display dims to the correct level. The final adjustment will have to be done when it's dark, so that you can correctly set the minimum brightness level.

Sensors

SENS1 is used to measure the in-cabin temperature but this sensor is actually mounted outside the case. This is necessary because the temperature inside the case will be higher than the ambient air temperature.

Fig.4 shows the wiring arrangements for both the internal and external sensors. As shown, SENS1 is attached to the thermometer box using a 3-way pin header and a length of shielded cable. This plug must be inserted with the correct polarity so it's a good idea to mark the polarity with a marking pen or dab of paint.

The external sensor is connected to a length of single-core shielded cable and the wires directly soldered to the PC board. Both sensors should be coated with a smear of silicone sealant (neutral cure; eg, Selley's Roof & Gutter Sealant) and either covered with heatshrink tubing or a short length of 5mm-diameter metal tubing.

We cut up a discarded car radio telescopic antenna to obtain the requisite diameter metal tubing.

Note that the circuit is designed to operate with both sensors connected. If one is disconnected or connected with reverse polarity, the display will show strange values.

If the thermometer is to be operated with only one sensor, it will be necessary to connect the two positive (+) input terminals for each sensor together on the PC board using a short length of hookup wire. In addition, one of the 15kΩ resistors supplying the sensor current should be removed from the circuit.

Alternatively, you can simply short out the terminal inputs for that particular sensor.

Calibration

All that remains now is the calibration. The first step is to cool the two sensors to 0°C. This is done using a mixture of fresh water and ice (made from fresh water). Add the ice to a bowl of fresh water and stir this continuously until the ice appears to have stopped melting. If you run out of ice in the solution, place some more into the water and continue stirring.

When you have a mixture of both ice and water and the ice has stopped melting, the water temperature is at 0°C.

The internal and external thermometer sensors can now be immersed in the mixture and allowed to sit there for at least a minute while the water is stirred. Now switch the thermometer off for a few seconds and switch it on again while holding the Display switch down. Release the switch and the display will show "CAL" to indicate that it is measuring the output voltage from each sensor.

When the calibration is complete, the display will show 0°C. Press the Display switch to check that the second sensor has been calibrated. It should show either "CAL", indicating that it is still being calibrated, or 0°C if the calibration has been completed.

Note that depending on the particular calibration number, the reading could jump to show -1°C on occasions. This is because the internal calculation to convert to °C does not consider results after the decimal point. This does not mean that the calibration has not been successful and nor does it alter the accuracy of temperature readings. However, if the readings appear to remain fixed at -1°C while the sensors are in the ice water, it means that the sensors were not given sufficient time to cool to 0°C before calibration took place and so it will be necessary to repeat the procedure.

Note too that the calibration procedure must be done again if one of the sensors is replaced.

Installation

Be sure to use automotive cable and connectors to connect the unit to the ignition switch wiring and to the chassis. The +12V supply is derived via the ignition switch and a suitable connection can usually be made at the fusebox. The ground connection can be made by connecting a lead to the chassis via a solder eyelet and a self-tapping screw.

The external sensor can be installed in any convenient location outside the vehicle and behind the front bumper bar is a good place. This affords a reasonable degree of protection and keeps it away from engine heat.

The internal sensor should be fitted in a location which is unaffected by direct sunlight and also away from any air vents. It's up to you where you fit it – under the glovebox or somewhere else under the dashboard is as good a location as any. **SC**

The LM335 Temperature Sensor: How It Works

The output from the LM335 temperature sensor is linear from -273.15°C to 125°C, with a slope that is typically 10mV/°C.

At 0°C, the output voltage is typically 10mV x 273.15 or 2.73V. However, the slope variation can range from 9.8mV/°C to 10.2mV/°C so we need some way of correcting for this variation.

Normally, these sensors are used with a trimpot connected to their adjust terminal, to allow the sensor slope to be adjusted to exactly 10mV/°C. In this case, however, we don't adjust the slope of the sensor but instead carry out a calculation to derive the temperature reading.

We can calculate the temperature from a given sensor if we know its slope characteristic. Looking at the output curve, shows that the output is 0V at the -273.15°C point. This temperature is often termed "absolute zero" since it is the coldest temperature possible. This temperature is also called 0K, where "K" denotes the Kelvin temperature scale (note that this is not called degrees K but simply K or Kelvin).

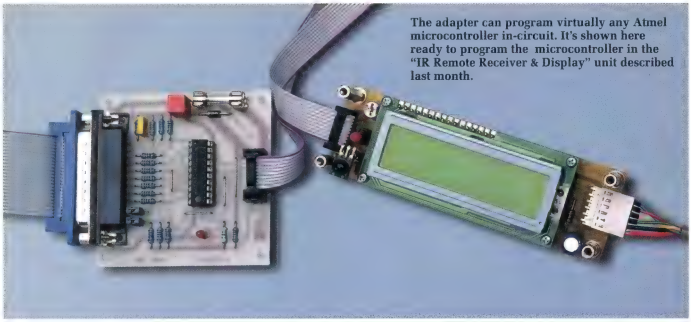
At 0°C, the output can range from 2.67V to 2.79V, depending on the sensor output slope characteristic. A simple formula allows us to derive the measured temperature from the voltage output of the sensor if we know the output voltage at a particular known temperature.

In our case, we use 0°C as the known temperature and the formula becomes: Temperature = (273.15 x Vout/Vout @ 0°C) -273.15. Once we determine the output voltage for the sensor at 0°C, we can then calculate the temperature for any other output voltage. For our calculations, we ignore the value after the decimal point since it has negligible effect on the result.

The analog output from the temperature sensor is converted into a digital word using an 11-bit A/D converter. This provides a value ranging from 0-2048 for a 0-5V analog input. The sensor output typically ranges from 2.33V - 3.98V for temperature readings from -40°C to +125°C.

During the calibration procedure, the A/D converter measures the sensor output and stores this value as the value to use for Vout @ 0°C. It does this for both sensors, with separate storage for each. The default setting before calibration is 2.73V at 0°C. This corresponds to an A/D value of 2048 x 2.73/5V or 1118.

Once the calibration number has been measured for each sensor, the values are stored and then the thermometer runs in its normal mode. In operation, the temperature sensor output voltages are converted to digital values and the calculation made to derive the temperature. This value is then shown on the LED display.



The adapter can program virtually any Atmel microcontroller in-circuit. It's shown here ready to program the microcontroller in the "IR Remote Receiver & Display" unit described last month.

In-System Programming Adapter for Atmel AVR Microcontrollers

If you're interested in experimenting with microcontrollers but aren't keen on spending big dollars on a "starter" kit, then this project is just what you've been looking for. Together with a Windows-based PC and some free software, it will allow you to program most Atmel AVR microcontrollers right in-circuit!

By PETER SMITH

IF YOU BUILT the "IR Remote Receiver & Display" described last month, this project will allow you to program the microcontroller chip yourself. In fact, that's why we developed this simple circuit but it can also be used for programming almost any Atmel AVR microcontroller in-circuit.

Basically, the device is a simple adapter that sits between the parallel port of your PC and the device to be programmed.

It's alive!

If you're new to microcontrollers, you're probably wondering what all the fuss is about. Why do they need to be "programmed"?

Microcontrollers are essentially microcomputers with built-in program memory, as well as other useful interface logic. When you buy one of these little devices from your local electronics outlet, its memory is blank. That is to say, it has no instructions "telling" it what to do.

Before it can be used in project "X", its memory must be programmed before it will perform as the project designer intended.

So grab your blank micro and let's head off to the lab for a memory implant ...

In days of old...

Once upon a time, end-user-programmable microcontroller memory was EPROM-based. Like the traditional UV-erasable EPROM memory most readers would be familiar with, it's programmed in a parallel fashion (one byte at a time) using high voltages.

But that's all in the past. Flash memory technology now allows fast electrical erasing and programming at normal chip supply voltage levels. Add to that a "smart" serial interface and programming the current crop of microcontrollers becomes an almost trivial task.

Atmel's Solution

Atmel microcontrollers incorporate a serial programming interface (SPI) that is designed specifically for in-system programming (ISP). Three I/O port pins do double-duty as control and data pins for the SPI. These are the serial input (MOSI), serial output (MISO), and serial clock (SCK) pins.

Programming is achieved by holding the reset (RST) pin low continuously from power-on, then sending the appropriate commands and data to the serial input (MOSI) pin. Memory contents can be read out via the serial output (MISO) pin, which also provides status information. Data is shifted in and out of the SPI under control of the serial clock (SCK) pin.

Connecting to the interface

In order to program one of these micros, we need to connect some kind of programming adapter to the SPI pins. On the AT90S2313 microcontroller (as used in our IR Remote Receiver & Display project), the SPI signals appear on the same pins as the upper Port B input/output (I/O) signals – PB5, PB6 & PB7. These pins behave like any other port pins during normal operation but take on the SPI functions when programming mode is entered.

In a typical design, external (user) circuits will be connected to some or all of the port pins. How do we prevent the obvious conflict that will occur between the user circuits and the SPI signals? One possible solution is to build in isolation resistors, as shown in the simplified circuit of Fig.1. This works well if the I/O pins are used for inputs only, or if used for outputs, only need to sink or source a few mA of current. A universal solution is shown in Fig.2, where the user circuits are isolated with an analog multiplexer when in programming mode (RST signal low).

Of course, the simplest solution of all would be to incorporate jumpers or DIP switches in the design so that

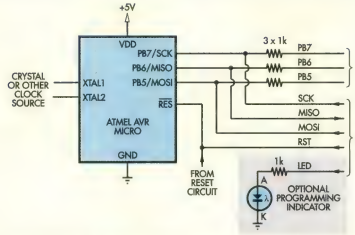


Fig.1: building in support for in-system programming in your designs is not difficult. In many cases, all that's required are three additional resistors, as shown here.

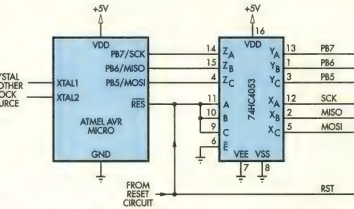


Fig.2: designs that need more drive from the micro's port pins may need a means of switching between the user circuits and programming interface. Here we show how this can be achieved using an analog multiplexer – an idea suggested by Atmel.

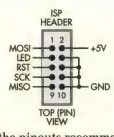


Fig.3: the pinouts recommended by Atmel for the serial programming interface. The header is of the standard 10-pin dual row variety.

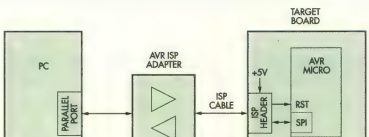


Fig.4: a block diagram of the complete programming system. Power for the adapter is supplied from the target board.

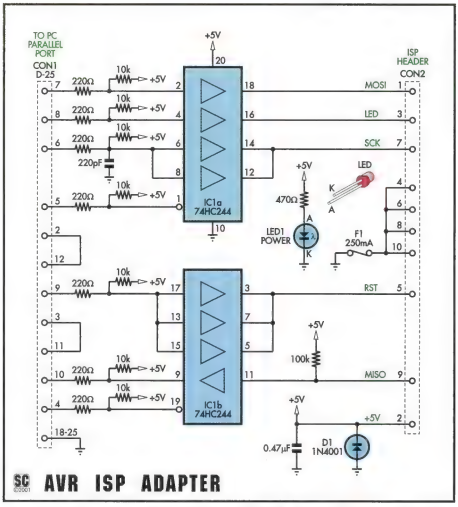


Fig.5: the circuit uses a single 74HC244 octal buffer (IC1a & IC1b) plus a handful of resistors. This provides signal conditioning and protects the microcontroller to be programmed and the PC's parallel port.

the user circuits can be completely disconnected from the port pins when the programming adapter is connected. Trouble is, it's a real pain having to continually install and remove jumpers each time you want to program and test your code (and for me, that's lots 'a' times!).

You might have noticed that we haven't provided any isolation at all in our IR Remote Receiver and Display project. Careful port pin assignments and a little hocus-pocus in the microcontroller's code allowed us to keep the parts count low.

To provide a connection point for the programming adapter, the SPI signals are routed to a standard 10-pin dual row header, with pinouts as defined by Atmel (see Fig.3). The header also provides power to the programming adapter.

Atmel's programming adapter

As luck would have it, Atmel has designed a simple programming adapter (they call it a "dongle") that plugs into the parallel port of your PC. In conjunction with Windows-based software, it allows programming of both the data (EEPROM) and program (FLASH) memory in most of their microcontrollers (see Fig.4).

Atmel supply the programming dongle with some of their microcontroller development kits. We know you probably don't want to buy the whole kit (!), so we've designed an equivalent adapter based on information freely available on the Internet.

Our programming adapter

Referring to the circuit diagram in Fig.5, you can see that all that is required is a buffer (IC1) and a handful of resistors to provide some signal conditioning and circuit protection. In fact, we've seen some circuits published that connect the parallel port lines directly to the microcontroller's SPI pins. We don't recommend that approach at all, as damage to your computer, or more likely your microcontroller, is entirely possible.

IC1 incorporates two quad tristate buffers, with their outputs enabled under software control by logic "low" signals on pins 1 and 19. As you can see, some outputs have been paralleled to increase drive capability. This is especially important for the reset (RST) line, which may have a strong pull-up to +5V on the target board.

Fuse F1 and diode D1 provide basic reverse-polarity protection. The idea here is that the diode shorts the +5V supply to ground and blows the fuse if you should inadvertently reverse the power connection to the board.

Note that reversing the ISP cable won't blow the fuse but it may damage IC1. This is much less likely to occur if you use polarised (shrouded) headers at both ends, as the header plugs are keyed to match and will only mate one way around.

By the way, we placed the fuse in the ground return instead of the power

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	7	10kΩ	brown black orange brown	brown black black red brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	7	220Ω	red red brown brown	red red black black brown

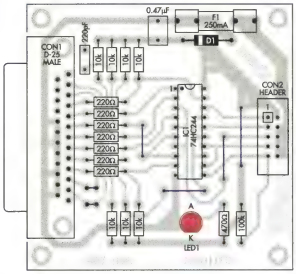


Fig.6: follow this parts layout to build the PC board. Make sure that IC1, LED1 & D1 are installed with the correct polarity.

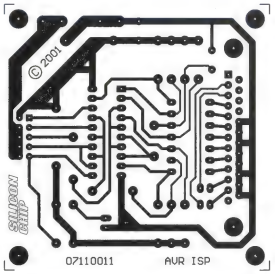


Fig.7: the full-size etching pattern for the PC board. Check your board against this pattern before installing any of the parts.

rail in an effort to avoid the potential meltdown that could occur under certain circumstances. If the PC doing the programming is also used to power the target board and the power supply is reversed, then +5V is connected directly to the ground return of the parallel port (can anyone smell something burning...?).

You may be wondering why we've specified a 250mA fuse when a smaller current rating would seem to be more appropriate. Unfortunately, smaller fuses have significantly higher resistance and would introduce a lot more "ground noise" into the circuit.

Construction

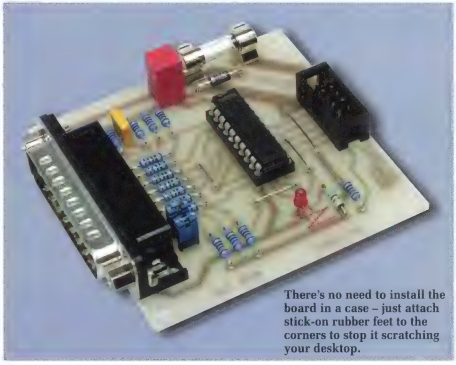
All parts are mounted on a 70 x 70mm single-side PC board. Referring to the overlay diagram (Fig.6), begin by installing the six tinned copper wire links and all the resistors. Next, install diode D1, the socket for IC1, the two capacitors and the fuse clips for F1.

The two connectors can be installed next. Make sure that pin 1 of CON2 is aligned as shown on the overlay diagram; when aligned correctly, the keyed side of the connector faces inwards (towards the centre of the board). Also of note is the mounting method for CON1, the D-25 connector. Some variants of these connectors have solder tails to secure them to the PC board, whereas others need to be secured with M3 screws and nuts. If you have the type that requires screws, then be sure to fit the screws and tighten them up before soldering any of the pins.

To complete the assembly, install IC1 and LED1, noting that the shorter lead of LED1 is the cathode and must be orientated as shown.

Housing

To keep costs down, we haven't specified a case for this project. Simply stick a small self-adhesive rubber "foot" in each corner to protect your desk and prevent the board sliding around too easily.



There's no need to install the board in a case – just attach stick-on rubber feet to the corners to stop it scratching your desktop.

Cables

If your PC sits on your desk, then you might find that you can plug the adapter directly into the parallel port connector. Alternatively, you can make up a suitable cable using one metre of 26-way IDC ribbon cable and two ca-

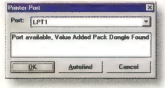


Fig.8: the software selects LPT1 by default. If you have connected to a secondary port, select it here.

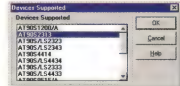


Fig.9: most AVR micros can be programmed. Choose your chip!

ble-mount 25-way IDC connectors. Remember that you need to strip one conductor off the ribbon cable before attaching the connectors.

You could also use shielded data cable and solder-type D-25 connectors for the job. These will be a little cheaper than the IDC versions, but will take a lot longer to assemble. We don't recommend pre-made printer extension cables be used, as they are generally too long and may introduce reliability problems; keep the length down to no more than about one metre if possible.

For the connection to the target board, make up a second cable using a short length (no more than one metre) of 10-way IDC cable and two 10-way cable-mount IDC plugs.

Parts List

1 PC board, code 07110011, 70mm x 70mm
1 90° PC mount 25-pin male 'D' connector (CON1) (Altronics cat P-3220)
1 10-pin dual row PC-mount header (shrouded or 'boxed' type) (CON 2)
2 10-pin IDC (cable mounting) header sockets
1 20-pin IC socket (machined pin type)
1 M205 250mA fast-blow fuse
2 M205 PC-mount fuse clips
1m 10 way IDC ribbon cable

Semiconductors
1 74HC244 octal buffer (IC1)
1 3mm red LED (LED1)
1 1N4001 1A diode (D1)

Capacitors
1 0.47µF 63V MKT polyester
1 220pF 63V MKT polyester

Resistors (0.25W, 5%)
1 100kΩ 1 470Ω
7 10kΩ 7 220Ω

Miscellaneous
4 small self-adhesive rubber feet
10cm (approx.) tinned copper wire for links

Optional (see text)
1 25-pin IDC male 'D' connector
1 25-pin IDC female 'D' connector
1m 26-way IDC ribbon cable

Testing

Without the parallel port cable connected or the fuse installed, connect the ISP cable between the programming adapter and the board that contains the microcontroller that you wish to program (the "target" board). Apply power to the target board and connect the positive lead of your multimeter to the cathode end of D1 and the negative lead to the righthand fuse clip (the clip closest to the ISP cable). Your meter should read +5V.

If all is well, install IC1 and the fuse, hook up the parallel port cable and get ready to "burn" your first microcontroller!

Power-up sequence

We recommend that you connect both adapter cables before applying power to the target board and remove power before disconnecting. This prevents damage to IC1 and the microcontroller that could be caused by "hot plugging" power to the adapter.

We've included current-limiting resistors on the adapter inputs to protect IC1 and your PC's parallel port lines, so it's not necessary to power off your PC when connecting or disconnecting the adapter. Even so, some readers have suggested to us that if you intend controlling home brew devices with your parallel port, it's not a bad idea to purchase a parallel port expansion card. The idea is that if something goes wrong, you damage the add-on card and (probably) not your motherboard. We agree!

Installing the software

You need a PC running Windows 95 or 98 to use this software. It might also run on Windows Me but we haven't tried it. Unfortunately, it doesn't work reliably on Windows NT4 and the same probably goes for Windows 2000, no doubt because it was never intended for these platforms.

If you haven't already done so, download the Atmel AVR ISR software from the Atmel ftp site at **ftp://www.atmel.com/pub/atmel/avr_isp.zip**. If you intend programming the microcontroller in the IR Remote Receiver and Display project (as we'll do in the following example), then you'll also need to download the program files for this project from the SILICON CHIP website at **www.siliconchip.com.au**

Unzip all files in the **avr_isp.zip** archive into a temporary directory and then double-click on the **setup.exe** file to launch the installation. Follow the on-screen prompts to complete the installation.

Setting up the software

When you run the AVR ISP software, you will be presented with a large empty window. From the menu bar, click on **Options** and choose **Change Printer Port**. If your adapter is connected to LPT1, you should get a

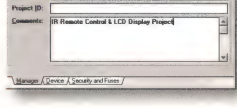


Fig.10: for convenience, all settings for the session can be saved in a project file.

display like that shown in Fig.8. Change the port if necessary, and check that you get a "Dongle Found" message. If not, there may be a problem with your adapter of parallel cable. Click on the **OK** button to close the dialog.

Still on the menu bar, click on **Project** and select **New Project**. A dialog box appears with a list of all supported microcontrollers (Fig.9). Select the AT90S2313 and click on the **OK** button. Three separate windows then appear, with the Project Manager window in front (Fig.10). Enter a title for the project, as well as any comments you like.

Next, click on the Program Memory window to bring it to the front. Displayed in this window, in hexadecimal notation, are all the bytes that will be written to the micro's FLASH (program) memory. Notice how all the bytes have been automatically initialised to FF, the value of "blank" (erased) memory.

Individual bytes can be edited directly in the memory windows but thankfully, we don't need to do that! To load the code for the IR Remote Receiver and Display project, click on **File** on the main menu bar and choose **Load**. A dialog box opens prompting you to choose the file to load, so navigate to wherever you unzipped the files for the project and choose the IRRLCD.HEX file. Now click on the **OK** button, and a message will appear stating that the file was loaded successfully.

For this project, we also need to program the data (EEPROM) memory. Click on the EEPROM Data Memory window to bring it to the front. Note that by default, these windows are cascaded, but can be moved around for easier access. Follow the same procedure as before, but this time load the IRRLCD.EEP file (Fig.11).

Burn baby, burn!

OK – check that everything is hooked up and power is turned on. Again from the main menu, click on **Program**. A drop-down list appears, giving you the option of erasing, programming, or verifying the device (FLASH memory) or EEPROM memory (see Fig.12).

You could perform each of these operations in turn but there is a quicker way. Select Auto Program from the list to have all the steps performed automatically in sequence.

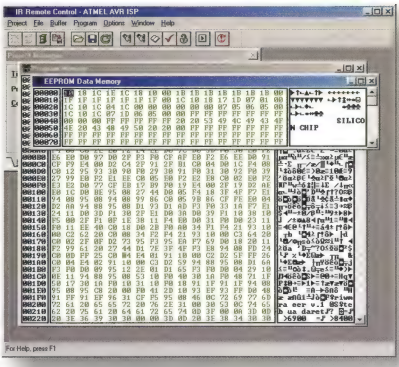


Fig.11: after loading the program and data files, your screen should look something like this.

If all is well, a small dialog box with a progress bar appears (see Fig.13). Should the Auto Program sequence fail for any reason, an appropriate error message will be displayed. Otherwise, you'll hear a "beep" when it's finished and see a message flash up so quickly that you don't have time to read it. This indicates success!

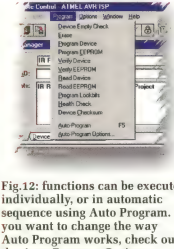


Fig.12: functions can be executed individually, or in automatic sequence using Auto Program. If you want to change the way Auto Program works, check out the Auto Program Options selection.

Fig.13: if you get this far, you're just seconds away from a successful implant!

Before closing AVR ISP, don't forget to save your project. Click on **Project** and select **Save As**. Enter a name for the project, navigate to wherever you want to save it and click **OK**. Note that project files should be saved with a .AVR extension for easy identification later. Then next time you want to reprogram the same device, simply select **Project**, **Open Project** to open the project file, and all your settings, including the program and data files, will be instantly reloaded.

Want more information?

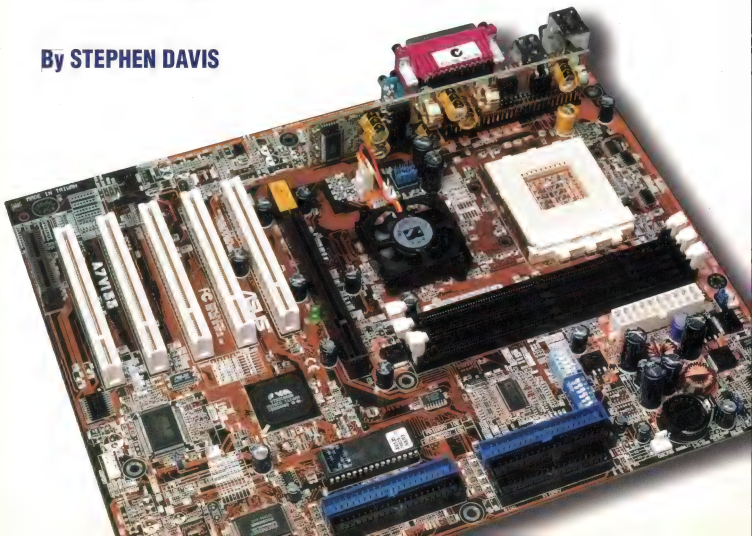
All the technical details on serial programming are included in the data sheets for each microcontroller type. Go to **www.atmel.com** to download your copy. While you're there, check out AVR Studio, a complete development environment for AVR micros – and it's free!

Many of our projects also use PIC microcontrollers from Microchip. Unfortunately, they cannot be programmed with this adapter. However, the PIC Test Bed described in our January 2001 issue includes a simple serial programming scheme. **SC**

Building a PC to die for – one man's experience

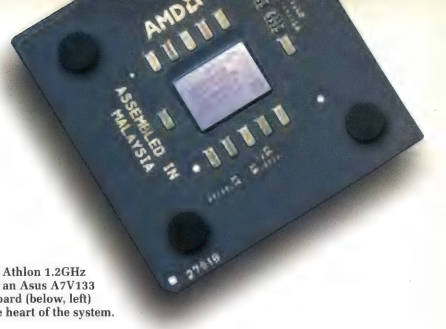
My own "PC To Die For" evolved separately from SILICON CHIP's machine, described in recent issues. Here's a look at the hardware used in my machine and how the problems were solved.

By STEPHEN DAVIS



FOR QUITE A FEW MONTHS before the publication of your article "A PC To Die For", I had been monitoring the prices of computer memory, CPUs and peripherals and waiting for the time when the items I wanted became more affordable. I spent a lot of time on the Internet reading hardware reviews, specifications and product comparisons and independently of Greg Swain, I slowly evolved a plan for a computer that was very similar to the one described in SILICON CHIP.

Basically, I wanted good performance but I also wanted value for money. After weighing up all the options, I decided on a machine that contained the following parts:



An AMD Athlon 1.2GHz CPU and an Asus A7V133 motherboard (below, left) are at the heart of the system.

(1) Microprocessor: 1.2GHz AMD Athlon (256MHz fsb)

My main reason for this choice is that the Athlon CPU costs less than the equivalent Pentium. I ended up buying the 1.2GHz Athlon because it seemed to offer the best compromise between price and performance in the Athlon range. At $275, I was happy with the purchase price, especially since the price a month earlier had been around $400.

The only disadvantage of the AMD chip that I could find is that they run hotter than the equivalent Pentium and so they require more effective cooling. They also require more power but that's not a problem provided you choose a big enough power supply.

(2) CPU cooling fan: Coolermaster EP5-6I11

In choosing a CPU cooling fan, I wanted a fan that was both powerful and quiet (I hate noisy computers). The cooler the chip runs, the greater the reliability or, if you are into overclocking, the more you can overclock it.

Of course, these attributes are usually regarded as being mutually exclusive, because the more powerful the fan is, the noisier it generally is and vice-versa.

Taking price into account as well, the best compromise seemed to be the Coolermaster EP5-6111. It is a ball-bearing fan and has excellent specifications, both with respect to noise and heat dissipation, beating more expensive (and more "hyped") coolers. The lower "specced" Coolermaster DP5-6H51 fan actually ships with boxed versions of the Thunderbird processor but this has nowhere near the specifications of the "E" range of coolers.

As an added bonus, this cooler comes with a special clip that makes it far easier to attach to the CPU than many other coolers. At $45, this seemed a reasonable amount to pay for a good quality fan.

(3) Motherboard: Asus A7V133 with RAID

The main reason I chose this motherboard was that it had received excellent reviews, incorporated the well-regarded VIA KT133 chipset and supported PC133 SDRAM (the cost of this type of memory being at an all-time low). As well, having two extra EIDE slots (thanks to the Promise Ultra ATA100 controller) means that up to eight hard disk drives, CD-ROMs or DVDs can be attached to this motherboard. And even if this option is not fully utilised, there are other advantages in having the extra slots.

For example, four hard drives or ATAPI devices with different specifications can all be single masters on their own EIDE channel. This allows all devices to work at their maximum potential, without being hampered by slave devices. A CD-ROM and CD burner can be connected to different channels (instead of as slave and master), making burning more efficient and reliable.

As well, in the BIOS, you can choose whether you wish to boot from a floppy, a CD, the primary EIDE channel, the secondary EIDE channel or from one of the Promise Ultra ATA100 channels. This means that you can have several hard disks in your computer and at bootup, you can choose which hard drive you wish to boot from – eg, you might have two or more operating systems that you wish to boot from but you don't want the complication of a single multi-boot disk.

An excellent idea for people with children who also use the same computer is to get a hard disk drawer, install a second hard drive in it and make that the child's hard drive. When the child wants to use the computer, he/she just plugs this drive in and the computer boots from that without touching "Dad's" hard drive. This is easily set up in the BIOS by setting the boot sequence to: (1) Child's hard drive; (2) Dad's hard drive.

Of course, if the child's hard drive is not present, it will boot to Dad's hard drive with no extra effort.

(4) Memory: 3 x 256MB Hyundai PC133 SDRAM

At the time of buying the parts for this computer, 256MB DIMM modules were selling for $79, with some retailers selling Hyundai RAM for this price. This brand of RAM has a good reputation for reliability and so $79 was very good value, especially considering that much of the RAM being sold for this price in many stores was generic "no-brand" RAM.

Thinking that I may be getting into multimedia at some stage, I bought three "sticks" of this memory to fill up all of the memory slots in the Asus

motherboard. It may have been overkill to buy this much memory but at that price, I couldn't resist it.

It pays to shop around when buying RAM. A friend of mine, who is in the process of building a similar system, found that he had to pay a premium ($90 vs $69) in order to obtain Hyundai memory.

(5) Video Card: Eagle GeForce2 MX400 (64MB)

Originally, I wanted one of the Matrox cards with video capture but their $600 price range dampened my enthusiasm. As a compromise, I ended up choosing the Geforce2 MX400 card, with the thought of obtaining a video capture card at some time in the future.

I bought a generic card (Eagle) after I was advised that there is not much difference between the generic cards and the big brandname cards, especially since they all use the Nvidia chipset. According to some sources, 64MB of video RAM is overkill but the cost differential between 64MB and 32MB was small enough to persuade me to go for the larger amount of memory.

According to several sources on the Internet, there is enough of a performance difference between the MX200 and the MX400 to justify spending the extra money for the latter.

(6) Floppy Disk Drive: a Panasonic for $30 seemed good value to me.

(7) CD-ROM Drive: a 52-speed Sony for $75 is a reasonable price to pay for a low-noise CD-ROM drive.

(8) Sound Card: Soundblaster Live Value! The cost of $95 speaks for itself.

(9) Hard Disk Drive: 60GB Deskstar IBM ATA 7200 RPM 60GXP

This hard disk was my choice because, despite its high rotational speed, it's quieter and generates less heat than equivalent models. The Deskstar series also have a reputation for being well made and the price premium over equivalent brands appeared to be relatively minor. I paid $430 for this drive.

(10) Monitor: Auriga 19CF 19-inch

When I first saw this monitor selling for $549, I thought that this must be another cheap generic monitor not worth wasting money on. However, when I checked it out on the Internet, I was surprised to find that its specifications were really quite good.

Among other things, this monitor

Swann's 56KB USB modem is a good performer.

boasts an Hitachi picture tube with a dot pitch of 0.22mm, has a maximum resolution of 1600 x 1200 @ 76Hz, and scanning frequencies of 30-98kHz horizontally and 50-160Hz vertically. In the end, I decided that it was too good to pass up for this price.

(11) Speakers: Altec Lansing AC554

A cost of $170 speaks for itself. These are a good set of multimedia speakers.

(12) Case: Aopen HQ08 Full Tower

This case has had very good reviews. The panel that holds the motherboard can slide right out of the box, the box itself is well made with no sharp edges, and it comes with a 300W power supply (recommended for Athlon CPUs).

I chose a full tower because they are easier to work in, cooling is less of an issue, and the thought of not having to worry about space for extra disk drives, etc is very appealing. This case was purchased for $190.

(13) Modem: Swann 56KB USB Modem

Swann modems have a good reputation and I wanted a USB modem to avoid the need for a separate power supply. There are discussions on the Internet as to whether USB modems are more unreliable than serial bus modems, with some people claiming that they suffer more dropouts than the latter. However, it appears that dropouts on a USB bus are only likely to occur if the bus is shared with other peripherals and the USB power supply is overloaded.

Because my mouse and keyboard are both PS/2 devices, I couldn't see myself sharing the USB bus with other peripherals while I was on the Internet. In the end, I bought the Swann USB modem for $115 and I am happy to report that it works fine – far better, in fact, than the internal PCI modem in my old computer.

PUTTING IT TOGETHER

The assembly of my machine was uneventful and proceeded in a similar fashion to Greg Swain's article "A PC To Die For", in the June 2001 issue of SILICON CHIP.

Of course, in order to partition and format the IBM hard drive, it had to be on the primary IDE port on the motherboard to begin with. But rather than use the old fashioned fdisk and format utilities, I used "IBM Disk Manager 2000", which I downloaded from IBM's website.

Booting from a floppy disk containing this program and following the on-screen prompts allowed me to create four equal-sized partitions on my 60GB hard drive and format them all within the space of five minutes!

I then used a utility downloaded from the Internet called "Memtest 86" to test my RAM modules. Intermittent crashes due to faulty RAM can be very frustrating (and difficult to track down) and I wanted to give my RAM a clean bill of health so that I could rule it out as a possible cause if I encountered instability problems later on.

Over the next six hours, I allowed this utility to thoroughly test my RAM. No errors were found I am happy to say. The address for the Memtest 86 download is: **www.memtest86.com**

Invalid page faults

Next, the installation of Windows 98SE (my preferred operating system) proceeded uneventfully and I was pleased that there appeared to be no problems during this phase. The first program I installed on my computer was "Norton System Works" and although there was a couple of "freezes" during the installation, I eventually completed the procedure.

The problems really started with some sort of conflict that appeared to be caused by the Soundblaster Live card. Random errors such as "SBLIVEXP caused an invalid page fault in kernel32. dll" occurred whenever I tried to use the soundcard's software.

My first approach was to download and install the latest Via 4-in-1 drivers, along with the latest drivers for the video card and the Soundblaster card. At the same time, I downloaded the driver for the Promise Ultra

ATA100 controller, so that the hard disk drive could eventually be transferred to an Ultra ATA100 EIDE slot. Unfortunately, this made no difference to the errors and even installing the sound card in PCI slot 3 which only shares its interrupt with the modem riser (not used) did not help.

At this point, I was grateful that I had cleared the RAM as a possible cause of problems. I was starting to wonder whether a BIOS upgrade may be the answer, when I saw a copy of the August edition of SILICON CHIP in my local newsagent.

It was a joy to purchase this magazine and read Greg Swain's article. I must admit that I was pleased to know that I was not alone in my frustrations. There is nothing worse than the gnawing fear that there is something wrong with one of the components you have bought and it is up to you to find out which component it is.

Anyway, although my symptoms were not the same as the symptoms described in Greg Swain's article (ie, I was not getting random lockups), I decided to follow his advice and upgrade the BIOS. My original version of the BIOS was avu1002a.awd – exactly the same as the original BIOS in Greg's machine.

Upgrading the BIOS

One thing that can go wrong with a BIOS upgrade is a power failure right in the middle of it. This is unlikely so I did not go to the extreme of obtaining an uninterruptible power supply. However, I did take the precaution of running "scandisk" on the floppy containing the upgrade (avu1005a.awd) and believe it or not, there was an unreadable sector right in the middle of the avu1005a.awd file.

This surely has to be a more likely cause of update failures than a power disruption. I unzipped the original avu1005a.awd file onto another floppy disk, checked it again and used this for the BIOS upgrade. The update went smoothly but I do admit that I wouldn't want to do it too often – it's a stressful 20 seconds.

After the BIOS upgrade, I rebooted my computer only to be greeted with the message "There is not enough memory to run Norton Antivirus".

I ran "Norton System Doctor" and it showed that my GDI resources, user resources, swapfile and RAM were all OK – as you would expect with nearly 800MB of memory! The conventional memory, however, was non-existent and as a result of this, random crashes still occurred while using Soundblaster Live! utilities. I then tried to open a command prompt by double-clicking command.com, only to be greeted with the error message "There is not enough memory to run this program".

In fact, this message would occur even if I used the Windows system configuration utility to turn off every background program except Explorer and Systray and then reboot the computer with only these two essentials running in the background.

At this stage, I decided to reformat my hard drive, reinstall the operating system and add the drivers and programs one-by-one until I found out what was causing this problem. After the installation of each individual driver, I tested the installation by trying to open a DOS prompt.

A clue at last

It was only when I installed the Soundblaster drivers that the out-of-memory errors started to occur. This would happen whether I used the most recent drivers or the ones released a couple of years ago. This was confusing to me, because I could find no reports of this sort of thing happening with other similar systems employing the Soundblaster Live! I was starting to think that it might be some strange hardware fault masquerading as a software fault.

Of course, the next course of action was to go to the Creative or Soundblaster website to see if there were any answers from product support. The answer was not immediately forthcoming but somehow I ended up at a site **www.americas.creative.com/support** where I somehow entered the right technical help search parameters and found an article which led to article Q253/9/12 in the Microsoft Knowledge Base.

The name of this article is "Out of Memory Error Messages With Large Amounts of RAM Installed." Apparently, any computer running Windows 95/98/Me with more than 512M of RAM may experience lockups or out of memory messages. This is because of an incorrect algorithm used by Vcache in determining maximum cache size based on the amount of RAM installed in the computer.

IBM's Deskstar hard disk drive.

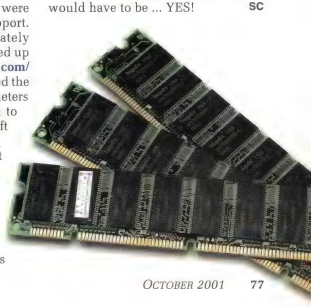
The cure for this bug is to reduce the amount of memory that Vcache uses to 25% of the system RAM by putting in a MaxFileCache setting in system.ini.

In my case, with 768MB of RAM the setting is as follows:

[vcache]
MinFileCache=196608
MaxFileCache=196608

Anyway, I performed all the required modifications and my computer now works like a charm. It is as smooth as silk and as stable and solid as a rock.

It has taken a lot of hours and some psychological stress to get this computer working but if people ask me if it was all worthwhile, the answer would have to be ... YES! **SC**



PRODUCT SHOWCASE

Nifty little Semiconductor Analyser from Peak

If you've ever been in the position of not knowing (a) what a particular semiconductor is, or (b) not knowing what its pinout is, or (c) both! (and haven't we all?), this little Peak Atlas semiconductor analyser from Pavika Management could be the answer.

Best of all, you don't even need to know how to drive it because it tells you everything. It has three leads fitted with clip probes. You simply connect them, in any position, to the semi under test and an LCD screen tells you what the device is, what coloured lead is connected to what pin, and then various parameters according to the device under test.

For example, with a transistor you find out the gain and the VBE – and the test currents of both. A diode will give you the VF and test current, LEDs the forward voltage (and even if it is a two or three-terminal bicolour LED) and so on.

It will test the vast majority of bipolar transistors, Darlington transistors, enhancement and depletion mode mosfets, JFETs, Triacs, Thyristors, LEDs, diodes and diode networks.

Contact:
Pavika Management
21 Grandview St, Parramatta NSW 2150
Phone: (02) 9890 8797
Fax (02) 9890 8387
email: pavika@bigpond.com

Dad, can I have a puppy for Christmas?

Now before you say "No!" you might like to look at AIBO, the 2nd generation entertainment robot from Sony.

Just like a normal puppy, you can give it a name (which it responds to), you can teach him tricks, he gets upset if you don't love him . . . but there's not a puddle nor a shredded paper anywhere!

AIBO has a 64-bit RISC CPU to control his motors, giving him (her?) a vast array of sophisticated movement. AIBO also has an inbuilt camera so he can take pictures of what he sees!

AIBO (which stands for Artificial Intelligence roBOt) is now available from many retail stores, SonyStyle and SonyCentral stores as well as by phone or online. Err . . . he's not exactly cheap at $3000 plus accessories!

Contact:
Sony Corporation
Phone: 1300 36 AIBO (1300 36 2426)
Website: www.aibo.com.au

Images floating in space: Hitachi's new "On-glass" projection system

Hitachi has released a projection system which can turn any window or glass surface into a super-bright video screen.

The new "On-Glass" system is said to be ideal for advertising in retail stores, shopping centres and open spaces, for presentations, etc.

The system consists of a high-brightness data projector and a clear film or screen which is attached to a clear glass surface. The 1m or 1.5m screen looks like a clear plastic film but is in fact a photopolymer, refracting light similar to a prism.

Light coming directly through the screen is unaffected but light angled at 35° is polarised and presented to the viewer as a bright image seemingly floating in space. The projector is a long way off-axis and therefore does not interfere with normal viewing.

The Hitachi data projectors used with the "On-Glass" system are high brightness models (CP-X980W and CP-X985W) with greater than 2,500 ANSI lumens. More importantly, these models feature digital keystone correction to correct the angle distortion.

A wide range of image sources are usable including computer graphics, video, TV signals, DVD players and so on.

Contact:
Hitachi Australia Ltd
13-15 Lyonpark Rd, Nth Ryde NSW 2113
Phone: 1800 789 799
Fax (02) 9888 4188
Website: www.hitachi.com.au

Lindsay Clout, Where Are You?

Lindsay worked at Jaycar in the early '80s when Jaycar was just starting. The business started small but got big.

Over the years hundreds & hundreds of people like Lindsay worked for Jaycar, Electronic Agencies & John Carr & Co.

Jaycar are looking for Lindsay & everyone else who has ever worked for them in the last 20 years.

Why? Because it's time to celebrate the 20th anniversary of the company and all staff, past and present are invited.

If you or someone you know has had a connection with the Jaycar group over this time, you are invited to attend a grand celebration party in November this year.

To register, contact Gary Rollans at Jaycar at grollans@jaycar.com.au or by regular mail at PO Box 6424 Silverwater NSW 2128 and they will put you on the register and send you more information.

Now, Margaret Parry...

DSE's White LED Torch Kit

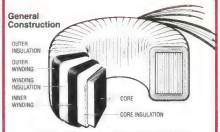
Dick Smith Electronics have sent us in one of their new White LED Torches, based on their kit (Cat K-3019) of the project described in the May 2001 SILICON CHIP.

This one has six white LEDs mounted in an Eveready torch case. It's a very easy kit to put together and the results are – dare we say it – brilliant!

In fact, it is so bright it is rather difficult to look into (not that you'd really want to). And the light output is that beautiful blue/white soft light which we described in the original article.

It's available now at all Dick Smith Electronics stores for $52.80. While the cost is significantly higher than "normal" torches, you'll never have to buy another globe.

TOROIDAL POWER TRANSFORMERS



Manufactured in Australia
Comprehensive data available

Harbuch Electronics Pty Ltd
9/40 Leighton Pl. HORNSBY 2077
Ph (02) 9476-5854 Fx (02) 9476-3231

DSE also has the single White LED Torch kit available at a much lower price: Cat K-3018 @ $14.60

Contact:
Dick Smith Electronics
2 Davidson St, Chullora NSW 2190
Phone: (02) 9642 9100
Fax (02) 9642 9153
Website: www.dse.com.au

New power meter from Yokogawa

In power measurement there are times when users want to confirm the input signal from various angles. The WT1600 Digital Power Meter allows the selection of 11 types of display formats – including waveform and bargraph displays. The trend display arranges the measurement value at each update interval in a time series. The time axis (T/div) can be set to anywhere from 3 seconds to 24 hours. Users can simultaneously observe changes in up to 16 parameters such as voltage, current, active power, and apparent power.

With a voltage range of 1.5V - 1000V, it can measure both the extremely small currents called for by energy-saving designs as well as the large currents involved in large-scale loads.

The WT1600 can have two kinds of input elements installed, allowing measurements using a 5A input element for small currents, and a 50A input element for a large currents.

The WT1600 has a higher measurement accuracy than any instrument in its class and a 1 MHz measurement bandwidth (voltage, current).

A built-in printer is located on the front panel allowing users the option of rack-mounting the instrument. Hard copies of the screen, numerical data, and harmonic analysis data can be output to the printer.

Both an internal hard disk and SCSI interface are included with the Ethernet option. Users can transfer saved files back and forth between a PC and the built-in hard disk of the WT1600. Screen image data can also be output to a network printer.

Contact:
Yokogawa Australia Pty Ltd
Private Mail Bag 24 Nth Ryde NSW 1670
Phone: (02) 9805 0699
Fax: (02) 9888 1844
Website: www.yokogawa.com.au

Two new PowerHouses

Dick Smith Electronics have opened two more "PowerHouse" stores, this time in Victoria. One is in the northern suburb of Preston, while the other is in Geelong.

A PowerHouse store carries a significantly increased range of products and everything is "plugged in, powered up and fully tuned," ready for customers to try out. There are now 11 DSE PowerHouse stores.

Contact:
Dick Smith Electronics
2 Davidson St, Chullora NSW 2190
Phone: (02) 9642 9100
Fax (02) 9642 9153
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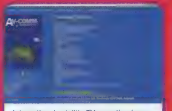

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VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

Beginner's radios – as they were

All people interested in electronics or Vintage Radio have to start at the bottom, as an absolute novice. Gradually, you come to recognise the jargon and understand the technology. This is the story of one teenager who become interested in radio many years ago.

Back in the 1950s, a teenage lad who lived on a farm near a small country town picked up a copy of "Radio & Hobbies". He read it cover to cover, understanding perhaps one word in 10 and he was immediately hooked on radio. A few of the radio suppliers had adverts displaying a G Marconi one-valve radio kit for the sum of five pounds; a lot of money for a young school boy with no money in the piggy bank. However, pocket money was scrupulously saved and the kit was duly ordered by post.

He anxiously waited for it to arrive. While waiting he installed a long wire aerial around 100 feet long (31m) and strung between the 40-foot (12m) high 32V windlight tower and the 25-foot (7.6m) windmill tower. The earth was a rusty old pipe driven into the ground around a metre deep. The set arrived and he then feverishly set about assembling the kit and trying it out. It didn't work. Oh dear; doom and gloom prevailed.

The radio was checked and re-checked to make sure assembly had been done correctly. The conclusion was that the valve must be faulty and it was sent back to the supplier. A replacement valve was received and then the set operated as it should.

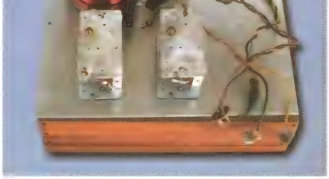
The lad was now getting really enthused and he tuned in regularly each night to see what he could hear. One night the family had been out and returned after midnight. Our young enthusiast turned on his radio and heard a weak radio station. What was so exciting about that when they are all rather weak on a one-valve set in the bush? In the 1950s, radio stations did not transmit 24 hours a day and most of the Australian stations had then closed for the night.

He had a book which listed most radio stations, their powers and frequencies. He came to the conclusion that he was hearing an extremely powerful broadcast station in the Philippines. A suitable jig around the bedroom was called for. I doubt his parents shared his enthusiasm. A radio station was a radio station and as long as Dad (a farmer) could hear the local news and weather forecasts on 3WV and Mum and younger sister could hear all their serials on 3LK, who cared!

G Marconi's 1-valve radio

The set was easy to assemble. It had a "breadboard" layout, using a 9mm

This is the rebuilt G. Marconi 1-valve set in its cabinet. It mightn't look much but it was my first working receiver.



A view of the works of the 1-valve receiver. It was built using a simple "breadboard" layout

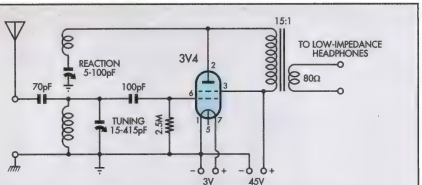


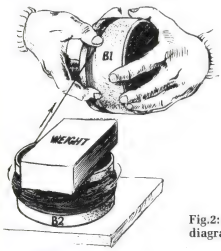
Fig.1: the "G. Marconi" was a basic regenerative radio receiver employing a single 3V4 valve. Its output was coupled to low-impedance headphones via an audio step-down transformer.

thick board with all the components and wiring layout stencilled onto the board in black paint. The valve socket had a lug soldered onto each pin. Each pin, along with a Fahnstock clip (made out of brass), was secured to the board with small wood screws. The components and leads were then attached to the various Fahnstock clips as per the stencilled overlay. No soldering was necessary.

Larger components such as the audio output transformer, tuning and reaction capacitors and the coil were mounted separately. The front panel of the set was printed cardboard. The instruction booklet consisted of six pages not including the front sheet and enough detail was included in the instructions to help constructors get it right first time. All in all, it was a very basic receiver and spartan methods of construction were used. But it was the lad's *first* radio and it *worked*.

The circuit (Fig.1) is typical of most one-valve sets of the era, with a few departures from the norm. A capacitor was wired directly between the aerial and the top of the tuned circuit with no aerial coupling winding. A 3V4 valve was used instead of a 1T4. The 1T4 would have used only half as much filament current. Expensive headphones were not included.

This is the instruction booklet that came with G. Marconi kit.



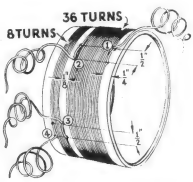


Fig.2: the instruction book included detailed diagrams on the coil winding.

An audio step-down transformer was used to couple between the valve and the low-impedance headphone, a cheap single earpiece unit. It had a metal band that went over the head and dug into the side. It wasn't comfortable but when you are so enthusiastic it doesn't matter.

Naturally, being so enthusiastic, all sorts of things were tried (much like our early experimenters), with about as much direction as a rudderless ship and with similar results. Ultimately the set was rebuilt and now resides in a roughly built cabinet that housed the set and the batteries. An on/off switch was added, an aluminium front panel and a phone jack so that better quality headphones could be used. By that time, slightly more comfortable headphones had been obtained.

Instead of the Fahnstock clips used for interconnecting the various parts of the circuit, our young enthusiast took to soldering the wires. I can tell you he didn't know much about soldering – dry joints were rather common. He didn't know much about how to make the metal free of oxides, nor much about how to tin wires. He was

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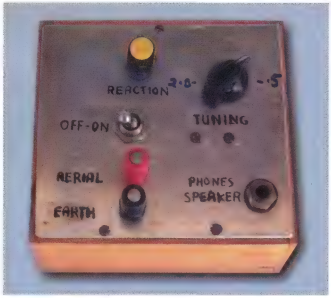


A front view of miniature 2-valve receiver. The design appeared in "Radio & Hobbies" in late 1950s and was capable of driving a loudspeaker.

This is the above-chassis view of the miniature 2-valve receiver. A 20kΩ potentiometer was used to control the amount of reaction.

more aware of how plumbers' soldering irons were used and things like Spirits of Salts (hydrochloric acid). Fortunately, he'd read that the use of such things caused radio wires to be eaten away so that mistake wasn't made.

Receiving faraway stations was of prime interest but the transmitting side of radio was intriguing too. It was known that his radio interfered with reception on his parent's set when the reaction control was turned up and the set squealed. He'd read somewhere about how transmitters operated and how voice and music were impressed on radio signals. So being a bright young lad, he tried to make a transmitter out of his-one valve set.

With the set oscillating and a speaker transformer and speaker connected in place of the headphones, he yelled into the speaker. His cousin wandered around the back yard with the family portable radio. He could hear what was being said around 15 metres away over the radio – as well as direct! It was time to swap tasks and our keen enthusiast then heard his "transmitter" too. Satisfaction!

There were no other radio enthusiasts for miles, so the idea of transmitting again was put on the back burner until his late teens when he got involved with the Emergency Fire Services (EFS) and was issued with a *real* transmitter. But that is another story.

In recent times I did an overhaul of that set and it still operates quite well. Its tuning range is from 590kHz to 2100kHz and its sensitivity is around 3mV for a reasonable level of audio on received stations. This set does form a special part in my collection – it was my first successful set!

Silver fish have eaten part of the booklet that came with the kit but some idea of the detail that was included in it can be seen in the excerpts (Fig.2). The circuit diagram shows that the receiver was very simple; ideal even today for those keen on building replicas.

I progressed to making all sorts of things, some that worked and some that didn't. During this period I purchased a 1000 ohms per volt multimeter, and this really did help me sort out any problems that I had.

A 2-valve miniature

"Radio & Hobbies" had a design for a miniature two-valve radio in the

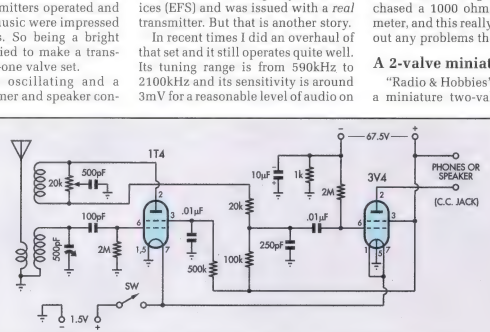


Fig.3: the "Radio & Hobbies" miniature 2-valve receiver. A 1T4 valve was used as a regenerative detector followed by a 3V4 audio output stage.

mid to late 50s. I'd about done all the experiments that I could think of with a one-valve set, so a "big" high performance two-valve set was the ideal next step. By this time, I had more experience and had a semblance of an idea of how to lay out a set. The axiom of "keep inputs away from outputs" was gradually seeping into my brain.

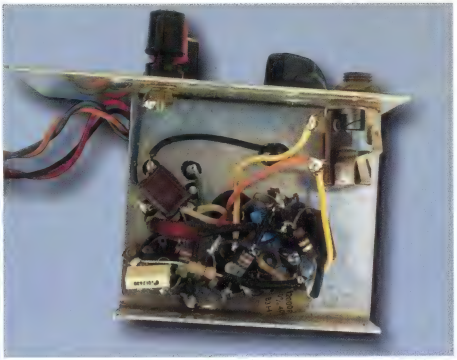
As can be seen in the circuit diagram, it uses a 1T4 as a regenerative detector followed by a 3V4 audio output stage. It was claimed to be able to drive a loudspeaker on nearer stations.

The Reinartz coil was a commercial miniature unit. The regeneration was controlled by a 20kΩ potentiometer across the reaction winding. When the potentiometer wiper is at the end nearest the tuned winding on the circuit, maximum regeneration and oscillation is achieved. Conversely, when the wiper is at the far end, the radio frequency (RF) energy in the plate circuit of the 1T4 is shunted to earth through the 500pF capacitor, hence no regeneration. In place of a bulky RF choke in the plate lead, a cheap alternative was used; a 20kΩ resistor.

In many circuits, a resistor is more practical compared to an RF choke and it is cheaper. An RF choke is essential where very little DC voltage drop across the component can be tolerated, whereas this can be substantial across a resistor.

Back bias for the 3V4 was obtained through the 1kΩ resistor and 10μF capacitor network in the negative HT line. The total current drain from the 67.5V battery was 4mA and 150mA from the 1.5V torch cell.

The performance of the set is superior to the one-valve set, as it should be. The tuning range is 510kHz to 2,000kHz. Its sensitivity is such that a 300uV signal is heard reasonably well with the detector not oscillating. It is capable of detecting a signal that is one tenth the level required by the one-valve set for the same performance. Extra valves do help. If the detector is oscillating, signals as weak as 3μV can be heard. This goes to show why very simple receivers were quite adequate to hear Morse code signals worldwide years ago.



An under-chassis view of the miniature 2-valve receiver. Point-to-point wiring was used between the valve sockets, the coil and the other hardware items.

I was very pleased with my miniature set which measured 125mm wide, 110mm high and 85mm deep, including the knobs. It was the smallest set I'd seen and it was complete with the batteries inside the case.

I built many other simple receivers, and in the Australian Radio College instructional kit of the 50s, there were many projects to build to help aspiring radio enthusiasts improve their ability. I remember building a one, a two and a three-valve receiver. The three valver was a good performer and even had shortwave on it, which widened my horizon of interest in radio.

Like many other projects that I built over the years, they were stripped down to make way for the next one, with the exception of the two above items which are all that remain of my early days in radio. I now regret that I "improved" my little G Marconi set but at that time very few people were interested in Vintage Radio – which is a part of our heritage. **SC**

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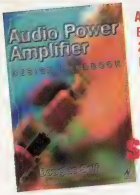

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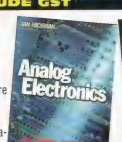

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February 1990: A 16-Channel Mixing Desk; Build A High Quality Audio Oscillator, Pt.2; The Incredible Hot Canaries; Random Wire Antenna Tuner For 6 Metres; Phone Patch For Radio Amateurs, Pt.2.

March 1990: Delay Unit For Automatic Antennas; Workout Timer For Aerobics Classes; 16-Channel Mixing Desk, Pt.2; Using The UC3906 SLA Battery Charger IC.

April 1990: Dual Tracking ±50V Power Supply; Voice-Operated Switch (VOX) With Delayed Audio; 16-Channel Mixing Desk, Pt.3; Active CW Filter; Servicing Your Microwave Oven.

June 1990: Multi-Sector Home Burglar Alarm; Build A Low-Noise Universal Stereo Preamplifier; Load Protector For Power Supplies.

July 1990: Digital Sine/Square Generator, Pt.1 (covers 0-500kHz); Burglar Alarm Keypad & Combination Lock; Build A Simple Electronic Die; A Low-Cost Dual Power Supply.

August 1990: High Stability UHF Remote Transmitter; Universal Safety Timer For Mains Appliances (9 Minutes); Horace The Electronic Cricket; Digital Sine/Square Generator, Pt.2.

September 1990: A Low-Cost 3-Digit Counter Module; Build A Simple Shortwave Converter For The 2-Metre Band; The Care & Feeding Of Nicad Battery Packs (Getting The Most From Nicad Batteries).

October 1990: The Dangers of PCBs; Low-Cost Siren For Burglar Alarms; Dimming Controls For The Discolight; Surfsound Simulator; DC Offset For DMMs; NE602 Converter Circuits.

November 1990: Connecting Two TV Sets To One VCR; Build An Egg Timer; Low-Cost Model Train Controller; 1.5V To 9V DC Converter; Introduction To Digital Electronics; A 6-Metre Amateur Transmitter.

December 1990: 100W DC-DC Converter For Car Amplifiers; Wiper Pulser For Rear Windows; 4-Digit Combination Lock; 5W Power Amplifier For The 6-Metre Amateur Transmitter; Index To Volume 3

January 1991: Fast Charger For Nicad Batteries, Pt.1; Have Fun With The Fruit Machine (Simple Poker Machine); Build A Two-Tone Alarm Module, The Dangers of Servicing Microwave Ovens.

March 1991: Transistor Beta Tester Mk.2; A Synthesised AM Stereo Tuner, Pt.2; Multi-Purpose I/O Board For PC-Compatibles; Universal Wideband RF Preamplifier For Amateur Radio & TV.

April 1991: Steam Sound Simulator For Model Railroads; Simple 12/24V Light Chaser; Synthesised AM Stereo Tuner, Pt.3; A Practical Approach To Amplifier Design, Pt.2.

May 1991: 13.5V 25A Power Supply For Transceivers; Stereo Audio Expander; Fluorescent Light Simulator For Model Railways; How To Install Multiple TV Outlets, Pt.1.

July 1991: Loudspeaker Protector For Stereo Amplifiers; 4-Channel Lighting Desk, Pt.2; How To Install Multiple TV Outlets, Pt.2; Tuning In To Satellite TV, Pt.2.

September 1991: Digital Altimeter For Gliders & Ultralights; Ultrasonic Switch For Mains Appliances; The Basics Of A/D & D/A Conversion; Plotting The Course Of Thunderstorms.

October 1991: Build A Talking Voltmeter For Your PC, Pt.1; Steam Sound Simulator For Model Railways Mk.II; Magnetic Field Strength Meter; Digital Altimeter For Gliders, Pt.2; Military Applications Of R/C Aircraft.

November 1991: Colour TV Pattern Generator, Pt.1; A Junktron 2-Valve Receiver; Flashing Alarm Light For Cars; Digital Altimeter For Gliders, Pt.3; Build A Talking Voltmeter For Your PC, Pt.2.

December 1991: TV Transmitter For VCRs With UHF Modulators; Infrared Light Beam Relay; Colour TV Pattern Generator; Pt.2; Index To Volume 4.

March 1992: TV Transmitter For VHF VCRs; Thermostatic Switch For Car Radiator Fans; Coping With Damaged Computer Directories; Valve Substitution In Vintage Radios.

April 1992: IR Remote Control For Model Railroads; Differential Input Buffer For CROs; Understanding Computer Memory; Aligning Vintage Radio Receivers, Pt.1.

June 1992: Multi-Station Headset Intercom, Pt.1; Video Switcher For Camcorders & VCRs; IR Remote Control For Model Railroads, Pt.3; 15-Watt 12-240V Inverter; A Look At Hard Disk Drives.

August 1992: Automatic SLA Battery Charger; Miniature 1.5V To 9V DC Converter; 1kW Dummy Load Box For Audio Amplifiers; Trouble-shooting Vintage Radio Receivers; The MIDI Interface Explained.

October 1992: 2kW 24VDC - 240VAC Sinewave Inverter; Multi-Sector Home Burglar Alarm, Pt.2; Mini Amplifier For Personal Stereos; A Regulated Lead-Acid Battery Charger.

February 1993: Three Projects For Model Railroads; Low Fuel Indicator For Cars; Audio Level/VU Meter (LED Readout); An Electronic Cockroach; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.5.

March 1993: Solar Charger For 12V Batteries; Alarm-Triggered Security Camera; Reaction Trainer; Audio Mixer for Camcorders; A 24-Hour Sidereal Clock For Astronomers.

April 1993: Solar-Powered Electric Fence; Audio Power Meter; Three-Function Home Weather Station; 12VDC To 70VDC Converter; Digital Clock With Battery Back-Up.

June 1993: AM Radio Trainer, Pt.1; Remote Control For The Woofer Stopper; Digital Voltmeter For Cars; Windows-Based Logic Analyser.

July 1993: Single Chip Message Recorder; Light Beam Relay Extender; AM Radio Trainer, Pt.2; Quiz Game Adjudicator; Windows-Based Logic Analyser, Pt.2; Antenna Tuners – Why They Are Useful.

August 1993: Low-Cost Colour Video Fader; 60-LED Brake Light Array; Microprocessor-Based Sidereal Clock; A Look At Satellites & Their Orbits.
September 1993: Automatic Nicad Battery Charger/Discharger; Stereo Preamplifier With IR Remote Control, Pt.1; In-Circuit Transistor Tester; +5V to +15V DC Converter; Remote-Controlled Cockroach.

October 1993: Courtesy Light Switch-Off Timer For Cars; Wireless Microphone For Musicians; Stereo Preamplifier With IR Remote Control, Pt.2; Electronic Engine Management, Pt.1.

November 1993: High Efficiency Inverter For Fluorescent Tubes; Stereo Preamplifier With IR Remote Control, Pt.3; Siren Sound Generator; Engine Management, Pt.2; Experiments For Games Cards.

December 1993: Remote Controller For Garage Doors; Build A LED Stroboscope; Build A 25W Audio Amplifier Module; A 1-Chip Melody Generator; Engine Management, Pt.3; Index To Volume 6.

January 1994: 3A 40V Variable Power Supply; Solar Panel Switching Regulator; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design; Engine Management, Pt.4.

February 1994: Build A 90-Second Message Recorder; 12-240VAC 200W Inverter; 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Engine Management, Pt.5; Airbags In Cars – How They Work.

March 1994: Intelligent IR Remote Controller; 50W (LM3876) Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Engine Management, Pt.6.

April 1994: Sound & Lights For Model Railway Level Crossings; Discrete Dual Supply Voltage Regulator; Universal Stereo Preamplifier; Digital Water Tank Gauge; Engine Management, Pt.7.

May 1994: Fast Charger For Nicad Batteries; Inductive Balance Metal Locator; Multi-Channel Infrared Remote Controller; Dual Electronic Dice; Simple Servo Driver Circuits; Engine Management, Pt.8.

June 1994: 200W/350W Mosfet Amplifier Module; A Coolant Level Alarm For Your Car; 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; PC-Based Nicad Battery Monitor; Engine Management, Pt.9.

July 1994: Build A 4-Bay Bow-Tie UHF TV Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Microprocessor-Controlled Morse Keyer; Dual Diversity Tuner For FM Microphones, Pt.1; Nicad Zapper (For Resurrecting Nicad Batteries); Electronic Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Battery Packs; MiniVox Voice Operated Relay; Image Intensified Night Viewer; AM Radio For Weather Beasties; Dual Diversity Tuner For FM Microphones, Pt.2; Electronic Engine Management, Pt.12.

October 1994: How Dolby Surround Sound Works; Dual Rail Variable Power Supply; Build A Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; Novel Alphanumeric Clock; 80-Metre DSB Amateur Transmitter; Twin-Cell Nicad Discharger (See May 1992); How To Find Patterns By Using PC Boards.

December 1994: Easy-To-Build Car Burglar Alarm; Three-Spot Low Distortion Sinewave Oscillator; Clifford – A Pesky Electronic Cricket; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dolby Pro-Logic Surround Sound Decoder, Pt.2; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier.

February 1995: 50-Watt/Channel Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel Thermometer With LCD Readout; Wide Range Electrostatic Loudspeakers, Pt.1; Oil Change Timer For Cars; Remote Control System For Models, Pt.2.

March 1995: 50 Watt Per Channel Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras; Remote Control System For Models, Pt.3; Simple CW Filter.

April 1995: FM Radio Trainer, Pt.1; Photographic Timer For Darkrooms; Balanced Microphone Preamp & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 6-Channel Decoder For Radio Remote Control.
May 1995: Build A Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction to Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Channel Radio Control Transmitter For Models, Pt.1.

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September 1995: Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1: Keypad Combination Lock; The Vader Voice; Jacob's Ladder Display; Audio Lab PC-Controlled Test Instrument, Pt.2.

October 1995: 3-Way Bass Reflex Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Battery Charger For Nicad Batteries; Digital Speedometer & Fuel Gauge For Cars, Pt.1.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector; Digital Speedometer & Fuel Gauge For Cars, Pt.2.

December 1995: Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Knock Sensing In Cars; Index To Volume 8.

January 1996: Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railpower Mk.2; Recharging Nicad Batteries For Long Life.

April 1996: Cheap Battery Refills For Mobile Phones; 125W Audio Amplifier Module; Knock Sensing For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter, Pt.3.

May 1996: Upgrading The CPU In Your PC; High Voltage Insulation Tester; Knightrider Bi-Directional LED Chaser; Simple Duplex Intercom Using Fibre Optics; Multi-Channel Radio Control Transmitter, Pt.4.

June 1996: BassBox CAD Loudspeaker Software Reviewed; Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: Build A VGA Digital Oscilloscope, Pt.1: Remote Control Extender For VCRs; 24-Cell Battery Charger; 3-Band Parametric Equaliser; Single Channel 8-Bit Data Logger.

August 1996: Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2: 350W Amplifier Module; Masthead Amplifier For TV & FM; Catherder PC Cat Deterrent.

September 1996: VGA Oscilloscope, Pt.3: IR Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Receiver; Cathode Ray Oscilloscopes, Pt.5.

October 1996: Send Video Signals Over Twisted Pair Cable; Power Control With Light Dimmers; Build A 12V DC Converter For Car Hifi Systems, Pt.1: IR Stereo Headphone Link, Pt.2; Build A Multi-Media Sound System, Pt.1; 80W/Channel Stereo Power Amplifier Module, Pt.1.

November 1996: 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; Repairing Domestic Light Dimmers; Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

December 1996: Active Filter Cleans Up Your CW Reception; A Fast Clock For Railway Modellers; Logic Probe Enhancements; Build A Sound Level Meter; 8-Channel Stereo Mixer, Pt.2; Index To Volume 9.

January 1997: How To Network Your PC; Control Panel For Multiple Smoke Alarms, Pt.1; Build A Pink Noise Source; Computer Controlled Dual Power Supply, Pt.1: Digi-Temp Monitoring Software.

February 1997: PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone Loud Sounding Telephone Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1997: Driving A Computer By Remote Control; Plasma Power PA Amplifier (175W); Signalling & Lighting For Model Railways; Build A Jumbo LED Clock; Cathode Ray Oscilloscopes, Pt.7.

April 1997: Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signalling; Cathode Ray Oscilloscopes, Pt.8.

May 1997: Neon Tube Modulator For Light Systems; Traffic Lights For A Model Intersection; The Spacewriter – It Writes Messages In Thin Air; A Look At Signal Tracing; Pt.2: Cathode Ray Oscilloscopes, Pt.9.

June 1997: PC-Controlled Thermometer/Thermostat, TV Pattern Generator, Pt.1; AudioRP Signal Processor; Stepper Motor Speed Controller For 12V/24V Motors; Manual Control Circuit For Stepper Motors.

July 1997: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Points Controller For Model Railways; Colour TV Pattern Generator, Pt.2: An In-Line Mixer For Radio Control Receivers.

August 1997: The Bass Barrel Subwoofer; 500 Watt Audio Power Amplifier Module; A TENs Unit For Pain Relief; Addressable PC Card For Stepper Motor Control; Remote Control Gate Or Garage Opener.

September 1997: Multi-Spark Capacitor Discharge Ignition; 500W Audio Power Amplifier, Pt.2; A Video Security System For Your Home; PC Card For Controlling Two Stepper Motors; HiFi On A Budget.

October 1997: Build A 5-Digit Tachometer; Add Central Locking To Your Car; PC-Controlled 6-Channel Voltmeter; 500W Audio Power Amplifier, Pt.3; Customising The Windows 95 Start Menu.

November 1997: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1997: A Speed Alarm For Your Car; Two-Axis Robot With Gripper; Loudness Control For Car Hifi Systems; Stepper Motor Driver With Onboard Buffer; Power Supply For Stepper Motor Cards; Understanding Electric Lighting Pt.2; Index To Volume 10.

January 1998: Build Your Own 4-Channel Lightshow, Pt.1 (runs off 12VDC or 120VAC); Command Control System For Model Railways, Pt.1: Pan Controller For CCD Cameras; Build A One Or Two-Lamp Flasher; Understanding Electric Lighting, Pt.3.

February 1998: Multi-Purpose Fast Battery Charger, Pt.1; Telephone Exchange Simulator For Testing; Command Control System For Model Railways, Pt.2; Build Your Own 4-Channel Lightshow, Pt.2; Understanding Electric Lighting, Pt.4.

April 1998: Automatic Garage Door Opener, Pt.1: 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 0-30kHz Sinewave Generator; Build A Laser Light Show; Understanding Electric Lighting, Pt.6.

May 1998: Troubleshooting Your PC, Pt.1; Build A 3-LED Logic Probe; Automatic Garage Door Opener, Pt.2; Command Control For Model Railways, Pt.4: 40V 8A Adjustable Power Supply, Pt.2.

June 1998: Troubleshooting Your PC, Pt.2; Understanding Electric Lighting, Pt.7; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1998: Troubleshooting Your PC, Pt.3 (installing A Modem And Solving Problems); Build A Video Controlled Multi Class-A Audio Amplifier Module; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1998: Troubleshooting Your PC, Pt.4 (Adding Extra Memory); Build The Ups-One Loudspeaker System; Simple I/O Card With Automatic Data Logging; Build A Beat Triggered Strobe; A 15-Watt Per Channel Class-A Stereo Amplifier.

September 1998: Troubleshooting Your PC, Pt.5 (Software Problems & DOS Gobbledygook); Build A Simple Alarm; A Warp-Wave Pedal For Your Guitar; Build A Plasma Display Or Jacob's Ladder; Gear Change Indicator For Cars; Capacity Indicator For Rechargeable Batteries.

October 1998: Low Quality AC Millivoltmeter, Pt.1: PC-Controlled Stereo-On-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charger For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1998: The Christmas Star; A Turbo Timer For Cars; Build A Power Amplifier, Pt.1: FM Transmitter For Video; Lab Quality AC Millivoltmeter, Pt.2: Setting Up A LAN Using TCP/IP; Understanding Electric Lighting, Pt.9; Improving AM Radio Reception, Pt.1.

December 1998: Protect Your Car With The Engine Immobiliser Mk.2; Thermocouple Adaptor For DC Voltmeters; A Rapid Battery Charger; Build Your Own Poker Machine, Pt.2; Improving AM Radio Reception, Pt.2; Mixer Module For FSB Glider Operations.

January 1999: High-Voltage Megohm Tester; Getting Started With BASIC Stamp; LED Stroboscope; Build A Disco Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3; Electric Lighting, Pt.10.

February 1999: Installing A Computer Network; Making Front Panels For Your Projects; Low Distortion Audio Signal Generator, Pt.1; Command Control Decoder For Model Railways; Build A Digital Capacitance Meter; Build A Remote Control Receiver For Model Lighting, Pt.11.

March 1999: Getting Started With Linux; Pt.1: Build A Digital Anemometer; 3-Channel Current Monitor With Data Logging; Simple DIY PIC Programmer; Easy-To-Build Multi-Purpose Low Distortion Audio Signal Generator, Pt.2; Electric Lighting, Pt.12.

April 1999: Getting Started With Linux; Pt.2: High-Power Electric Fence Controller; Bass Cube Subwoofer; Programmable Thermostat/ Thermometer; Build An Infrared Serial Data Link For Cars; Electric Lighting, Pt.13; Autopilots For Radio-Controlled Model Aircraft.

May 1999: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Heart Of LEDs; Build A Carbon Monoxide Alarm; Electric Lighting, Pt.14; Pt.3: Sinewaves.

June 1999: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1; Hard Disk Drive Upgrades Without Reinstalling Software?

July 1999: Build A Dog Silencer; 10uH to 19.99mH Inductance Meter; Build An Audio-Video Transmitter; Programmable Ignition Timing Module For Cars, Pt.2; X-Y-Z Table With Stepper Motor Control, Pt.3.

August 1999: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; X-Y-Z Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1999: Automatic Addressing On TCP/IP Networks; Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Electrolytic Capacitance Meter; X-Y-Z Table With Stepper Motor Control, Pt.5; Peltier-Powered Can Cooler.

October 1999: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomouse The Robot, Pt.2: X-Y-Z Table With Stepper Motor Control, Pt.6; Introducing Home Theatre.

November 1999: Electric Lighting, Pt.15: Setting Up An Email Server; Speed Alarm For Cars, Pt.1; Multi-Colour LED Christmas Tree; Build An Intercom Station Expander; Foldback Loudspeaker System For Musicians; Railpower Model Train Controller, Pt.2.

December 1999: Electric Lighting, Pt.16; Build A Solar Panel Regulator; The PC Powerhouse (gives fixed +12V, +9V, +6V & +5V rails); The Fortune Finder Metal Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Volume 12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Build The Picman Programmable Robot; A Parallel Port Interface Card; Off-Hook Indicator For Telephone Lines.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; An Ultrasonic Parking Radar; Build A Safety Switch Checker; Build A Sine/Square Wave Oscillator; Marantz SR-18 Home Theatre Receiver (Review); The "Hot Chip" Starter Kit (Review).

March 2000: Doing A Lazarus On An Old Computer; Ultra Low Distortion 100W Amplifier Module, Pt.1: Electronic Wind Vane With 16-LED Display; Glowplug Driver For Powered Models; The Oz-Trip Car Computer, Pt.1: Multisim Circuit Design & Simulation Package (Review).

April 2000: A Digital Tachometer For Your Car; RoomGuard – A Low-Cost Infrared Alarm; Build A Hi-Fi Valve Buffer; The Oz-Trip Car Computer, Pt.2: Build A Temperature Logger; Atmel's ICE 200 In-Circuit Emulator; How To Run A 3-Phase Induction Motor From 240VAC.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; Build A LED Dice (With PIC Microcontroller); Car Exhaust Gas Analyser; Translate Documents With Scan-Codes To ASCII); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge With Digital Readout; Parallel Port VHF-FM Receiver; Li'l Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.1; Computers In Cars Or The Home.

July 2000: A Moving Message Display; Compact Fluorescent Lamp Driver; Ei-Cheapo Musicians' Lead Tester; Li'l Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.2; Say Bye-Bye To Your 12V Car Battery.

August 2000: Build A Theremin For Really Eerie Sounds; Come In Spinner (writes messages in "thin-air"); Loudspeaker Protector & Fan Controller For The Ultra-LD Stereo Amplifier; Proximity Switch For 240VAC Lamps; Structured Cabling For Computer Networks.

September 2000: Build A Swimming Pool Alarm; An 8-Channel PC Relay Board; Fuel Mixture Display For Cars, Pt.1: Protoboards – The Easy Way Into Electronics, Pt.1; Using The Solar Cell.

October 2000: Guitar Jammer For Practice & Jam Sessions; Booze Buster Breath Tester; A Wand-Mounted Inspection Camera); Installing a Free-Air Weather Station For Your Car; Fuel Mixture Display For Cars, Pt.2; Protoboards – The Easy Way Into Electronics, Pt.2.

November 2000: Santa & Rudolf Christie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Electronic Thermostat; Protoboards – The Easy Way Into Electronics, Pt.3.

December 2000: Home Networking For Shared Internet Access; Build A Bright-White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Build A Morse Clock. Protoboards – The Easy Way Into Electronics, Pt.4; Using The Solar Cell, Pt.2.

January 2001: LP Resurrection – Transferring LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & Testbed; Wireless Networking.

February 2001: How To Observe Meteors Using Junked Gear; An Easy Way To Make PC Boards; Li'l Pulser Train Controller; Midi-Mate – A MIDI Interface For Cars, Build The Bass Blazer; 2-Metre Elevated Groundplane Antenna; The LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Driving Your Phone From A PC; Making Photo Resist PC Boards At Home; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Development Board; Protoboards – The Easy Way Into Electronics, Pt.5, More MIDI – A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; A Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Improved Nicad Battery Charger; Computer Tips – Tweaking Internet Connection Sharing.

May 2001: Powerful 12V Mini Stereo Amplifier; Microcontroller-Based 4-Digit Counter Module; Two White-LED Torches To Build; A Servo With Lots Of Grunt; PowerPak – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection, Pt.1; Computer Tips – Tweaking Windows Internet Settings.

June 2001: Fast Universal Battery Charger, Pt.1; Phonome – Call, Listen In & Switch Devices On & Off; Li'l Snooper – A Low-Cost Automatic Camera Switcher; Build a PC Games Port Tester; Using Linux To Share An Internet Connection, Pt.2; A PC To Die For, Pt.1 (Building Your Own PC).

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; A PC To Die For, Pt.2; Computer Tips – Backing Up Your Email; Digital Amplifiers Are Here (Feature).

August 2001: Direct Injection Box For Musicians; Build A 200W Master Amplifier Module; Overnight Reminder For Cars; 40MHz 6-Digit Frequency Counter Module; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: MP3 – Changing The Way You Listen To Music; Making MP3s – Rippers & Encoders; Build Your Own MP3 Jukebox; PC-Controlled Mains Switch; Personal Noise Source For Tinnitus Sufferers; The Li'l Scooper Snooper Directional Microphone; Using Linux To Share An Internet Connection, Pt.3; Newsgroups – Common Terms & Abbreviations.

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Signal pickup for digital speedo

I have a need for a digital speedo in my 1995 Daihatsu Charade. The analog speedo has a reed relay attachment that produces a 10ms square wave output that feeds into the engine CPU. This square wave has a rate of 40 pulses at 60km/h and so forth.

In "Ask Silicon Chip" for June 2001, page 99, you say that the photo interrupter uses a magnetic PU to detect shaft rotation.

Could I use the speed alarm circuitry to provide a digital speed readout from my car's speedo square wave? I have not read the November & December 1999 issues about this device. Why did you not use the square wave output from the speedo of most cars with fuel infection systems?

My car computer repairman says that most EFI cars have this feature. (D. J., Banora Point, NSW).

● You can use the speedo signal from your car to drive the Digital Speedometer. Just connect the signal to the pin 2 input of IC2a via the 1kΩ resistor. This terminal is the top of L1, as shown on the circuit.

In our reply in June 2001, we commented that we used a magnetic pickup not a photo interrupter, to allow for relative movement between the suspension and the drive shaft. We could have used the speedo signal available on many cars but we provided the magnetic pickup so that all cars are catered for.

Earth stake corrosion can cause interference

I read with interest the letter in the June 2001 issue of SILICON CHIP regarding interference on 4QR on 612kHz. I listen to this same station and experience a loud "hum" most of the time. It is especially prominent when using a high-quality FM tuner that has an indifferent AM section. To my surprise, I discovered recently that the "hum" would disappear when I switched on any of the heating elements of the kitchen stove. I have no idea why this occurs – any suggestions? (D. A., Aspley, Qld).

● It could suggest a problem with your mains wiring. Check the main earth stake for your home as the connection may have corroded away. Also, is the oven earthed properly?

(Editor's note: this correspondent subsequently confirmed that the main earth stake connection had corroded. Renewing the connection fixed the problem).

LP Doctor neon problem

I have just finished assembling an "LP Doctor" supplied as a Dick Smith Electronics kit. I have not yet got around to testing it because there is one thing puzzling me. The neon in the power switch is on all the time. It does get brighter when the switch is on but it is still clearly visible when the switch is off.

Have you any idea why this is so? I am worried that it might indicate a faulty switch and I don't want to complete the assembly while ever that chance exists.

I've got around 600 LPs which I enjoy listening to, despite the "clicks and pops". It will be nice to hear them in a quieter mode, when I get the LP Doctor working. (J. L., Geilston Bay, Tas).

● The neon is on because the .01μF capacitor across the mains switch is letting sufficient voltage through to fire the neon. However, since you need at least 100V across the neon/resistor to fire it, we wonder if you have the mains transformer, power supply and rest of the circuit connected. Or perhaps you have no ICs installed on the PC board?

Thermistor in Nicad battery packs

What would I have to do to the Universal Fast Battery Charger described in the June & July 2001 issues to be able to charge batteries such as 1400 or 1500mA.h AA batteries. Also is the thermistor that you attach to the battery pack when charging Nicad or NiMH cells for safety or is this used to detect the peak charge of the battery pack? (R. R., via email).

● Use the 2A.h setting for 1.4-1.5A.h batteries. The thermistor detects temperature rise in the battery pack and is a backup to the normal end-of-charge detection.

Adjusting VR5 in the DI Box

In your article on the DI Box in the August 2001 issue you refer to the purpose of VR5 (offset adjustment for IC2) but you do not give any instructions on how to set this in the "Testing" section. Neither is VR5 included in the parts list. (P. S., Glen Innes, NSW).

● VR5 should be a 16mm 10kΩ linear potentiometer. To adjust it, connect a DMM across the bass pot (VR2) and set VR5 for 0V DC. This eliminates any DC current through the bass control and stops it from becoming noisy.

Pulse switching makes motor noise

I have just built the 24V motor controller described in the June 1997 issue of SILICON CHIP and it works fine except for one thing. When I reduce the speed, the motor sounds like a rampaging cricket.

I have followed your instructions (fitting the capacitor and diode) and checked the board and components. Is this common and do you know how to stop it? (J. E., via email).

● Unfortunately the noise is a side effect of the pulse width modulation and it is most noticeable when you

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Troubles with ignition system

I recently purchased the Universal High Energy Ignition (June 1998) kit, along with the Programmable Ignition kit (June & July 1999) to go with it. I built and tested them on the vehicle and they both worked. I then installed them properly and they don't work. First, I need to know how to change the current limiting part of the circuit as I need it to fire two coils. I know the trigger part of the circuit is working as the tacho feed is working and the Programmable Ignition is also working and sending a signal to the ligh-Energy Ignition.

I need to know how I can test the signal that comes from pin 7 of IC1 and to the transistor as the fault is somewhere around there. The plastic washer for the transistor melted after trying to get the circuit to work. How can I test the transistor?

I also read about the Multi-Spark CDI kit and I know the trigger circuits are the same. I am wondering if it is possible to convert the high energy kit to a multi-spark kit. If this is possible how would I go about it? (S. G., via email).

- The pin 7 output of IC1 is normally high and goes momentarily low when the coil is to be fired. You would not be able to monitor this unless you have an oscilloscope. The output transistor has possibly been destroyed as the washer melted. This would suggest that the transistor was wired directly between the ground at the emitter via the 0.1Ω resistors and the 12V supply rather than to the coil.

The best way of increasing current limit is to parallel another 0.1Ω 5W resistor across the other two existing resistors.

The capacitor discharge ignition can be used with the programmable ignition but with some modifications to invert the signals. We suggest you get the high energy unit going first. It cannot fire two coils and nor can it be used in multi-spark mode.

operate at very slow speeds. You might try reducing the pulse frequency by increasing the .068μF capacitor at pin 5 of the TL494. Try 0.22μF at pin 5 and increase the 10kΩ resistor at pin 6 to 56kΩ. This will reduce the frequency to 200Hz.

Power transistors for 100W amplifier

I'm having trouble finding the power transistors for the 100 watt LD amplifier described in your March & May 2000 issues. Do you know of any distributors which may stock the following: MJL1302A PNP and MJL3281A NPN power transistors?

Also I noticed that in the March issue the mono amplifier clips just after 100 watts while the stereo version in the May 2000 issue clips at 90 watts. Is this due to limitations of the toroidal transformer used or something else? (B. M., via email).

- The stereo version clips at 90W with both channels driven. With one channel driven, the distortion curves would be more or less identical to those shown in the March issue. This is solely due to transformer regulation and is not a problem.

You can purchase the MJL transistors from Farnell Electronics. Phone 1300 361 005.

Connecting the Immobiliser to the HEI

I have just purchased two SILICON CHIP kits from Jaycar, the Engine Immobiliser Mk2 from December 1998 and the Universal High Energy Ignition kit from June 1998. I wish to combine the two kits in the ignition kit case. Can you see any problems in combining the two kits? If the answer to question 1 is OK, do I pull down (earth) the input or the output of the ignition kit with the Immobiliser? (B. H., via email).

- Simple: just connect the Immobiliser output to the coil output of the ignition circuit. In effect, the Immobiliser power transistor is connected in parallel with the power transistor in the HEI circuit. When the Immobiliser transistor is on, the HEI transistor cannot interrupt the coil current and so no spark voltage is delivered.

Minimitter MkII FM transmitter

I've constructed a Minimitter MkII FM transmitter as described in the April 2001 issue. However, I had to turn my stereo to the highest volume so that I could just hear the music from my CD player through the transmitter & tuner, with some noise. (J. T., via email).

- It seems that you are not applying sufficient audio signal into the Minimitter. Adjust trimpots VR1 and VR2 for a larger signal level from your FM tuner. Alternatively, you may be tuned into a harmonic of the transmitted frequency rather than the actual signal. Try retuning the transmitter and FM tuner.

WARNING!

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Dropout problem with 12V amplifier

I have recently constructed the 12V Mini Stereo Amplifier as described in the May 2001 edition of SILICON CHIP magazine. But when connected to a 12V battery (or power supply), a mini disc player and some 8Ω Bose speakers, the sound cuts out with a thump every three seconds or so. The current consumed also increases to about 3A and the voltage correspondingly drops (causing the power amps to drop out).

This happens only when an audio signal is present; turning the volume up to maximum with no input does not make it happen. When it does happen, both speakers do it at the same time.

I have checked all components, soldering and tracks and they seem fine. I disconnected 10Ω resistor at pin 1(7) of IC1 and injected the audio at that point, both power amps worked OK with no cutouts (but some distortion was evident). Next I put the resistor back and put the audio input at the 10μF NP capacitor on pin 8(14) of IC1 and the problem was back. This led me to believe there was something amiss around the second op amp.

Jaycar Electronics supplied a 1μF MKT type capacitor instead of an electrolytic non polarised variety. I replaced this with a different 1μF MKT and the problem was still there. I then tried other capacitors until I used a 0.1μF greencap and the amp worked fine (the audio seemed a little distorted but that is most likely due to the wrong value capacitor).

Will this be a problem to use an MKT capacitor instead of a electro? It seems I have a problem around this point. Could it be component tolerances? I have replaced IC1 as it was easy (thanks to the socket – but no effect) and I could replace the other components around IC1b&d as I have them at home but 1μF NP electros are very hard to find here in Singapore. (J. L., via email).

● Depending on how loud you play it, the 12V stereo amplifier can draw 5A or more and if you are using a small battery or power supply the voltage may drop below 9V or so, and this will be sufficient to mute the TDA1519As in both channels.

If your battery or power supply seem beyond reproach, check the voltage at the PC board with an analog meter. If it is fluctuating in accordance with peaks in the music it may just be that the resistance of the connecting wire is too high. If this is the case, use thicker hookup wire such as 4mm auto wire.

The 1μF MKT capacitor is fine; better than an electro, in fact.

Turbo timer false triggers

I recently bought and put together one of the Turbo Timer kits described in the November 1998 issue and it works well except for one thing. Instead of activating the relays only when the ignition is turned off, they are activated as soon as the ignition is turned on and then it switches itself off after the set time. This means that to activate the timer after going for a long drive, you have to turn the car off, then turn it back on (timer activates straight away) then take the keys out.

I've checked and double-checked the layout. Help. (J. M., via email).

● Some vehicles do not drop the ignition voltage fast enough to trigger the Turbo Timer circuit. You can improve this by increasing the 2.2μF capacitor value connecting to pin 2 of IC1 to a much larger value. A 22μF capacitor should be sufficient.

LM3876 vs LM3886 amplifier chips

I have just built your 50W Audio Amplifier kit for my home stereo. This uses the LM3876 audio amplifier chip from National Semiconductor. However, the data sheets for this chip suggest that it was designed to work with 8-ohm speakers whereas mine are 6-ohm. Can I just substitute the LM3886 chip instead, as it seems to better suited for lower impedance loads? (P. F., via email).

● We would not bother substituting the LM3886. The performance difference will be very slight, certainly not noticeable to the ear. The LM3876 will work quite happily with 6-ohm speakers but in any case, the actual impedance of your speakers will be above 6Ω for most of the audible spectrum. If you really want to improve the performance, you need to go to one of our discrete bipolar transistor amplifiers such as the Plastic Power 125W module described in April 1996. SC

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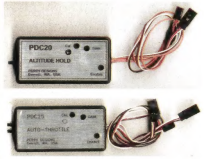

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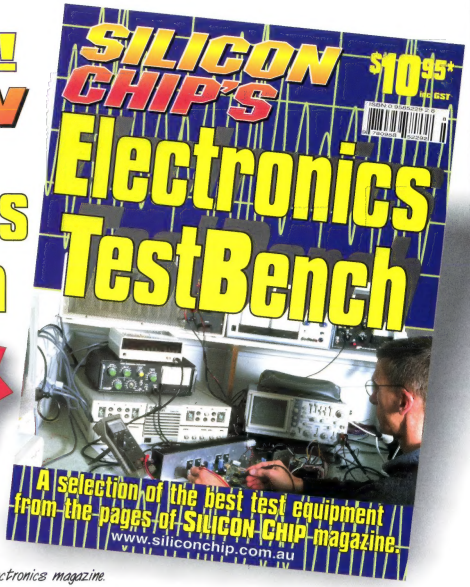

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To understand why $6,843 is a fair price to pay for VAF kit speakers, read 580 words from a violinist who can't use a screwdriver.

The following is an excerpt from a review which appeared in Audio Video Lifestyle Consumer Guide '99 by Sian O'Neale.

"Phillip Vafiadis is the creative talent behind the brand and his aim with VAF Research is to market kit loudspeakers of uncompromising quality at the serious end of the hi-fi market.

The VAF range is priced from $312 a pair right up to $8,863 a pair*, so we're talking serious money here for serious equipment.

We at AVL magazine have been particularly impressed with DC-X series.

These kit loudspeakers are not the standard packages from consumer electronics stores. In fact, you won't find these products in any store. The company prefers to cut out the middle-men and save buyers money, so every product is available factory-direct.

The VAF Signature series includes the Signature 1-66 and 1091 loudspeakers. Taking delivery of the 120kg 1-66 floorstanding speakers is something of an experience; I have never seen such an imposing crate for a pair of loudspeakers before. Fortunately my brother Crispin is capable with the screwdriver and we took out the massive 1-66s. You will need quite a bit of muscle and help to unpack these speakers and get them where you want them. The engineering and attention to finish that has gone into these fully assembled VAF Research 1-66s is simply awesome.

These elegant but powerful looking loudspeakers come with removable velcro attached grilles in a 3-way design; a 210mm hard paper bass driver with solid copper phase plugs and a 25mm double chamber sonotex dome tweeter with a pure silver wire voice coil. Turn the speakers around and you have very high quality gold plated binding posts which allow for bi-wiring and tri-wiring.

The same meticulous attention to detail and build quality also goes into the smaller 1-91 models, three of which are presented as left and right rear surrounds and a centre channel speaker for home theatre use (which has a custom-designed grille for a centre channel speaker). But the 1-91 loudspeakers have been designed to also perform as high quality studio monitors with the same superb sound as the 1-66s.

The speakers were designed to be used close to a rear wall and that's how customers use them, ideally 15cm-40cm from the nearest wall. But I think the speakers sound better when they can breathe more easily. Find the right position for the room and you will be richly rewarded.

The big VAFs deliver a stunning soundstage which is wonderfully insightful and involving. Large scale orchestral works have a level of depth and accuracy that only the best loudspeakers can manage.

As a violinist, I am often left unimpressed with the sound of the violin through so many loudspeakers (even high-end models), but here the presentation is accurate and engrossing. Instrument separation between different members of the orchestra is faultless.

This is particularly obvious when listening to Hans Zimmer's evocative soundtrack for The Thin Red Line in which quiet, gentle music provides so much power and atmosphere.

As a system for home theatre, together with the smaller satellite 1-91s, VAF has assembled an incredible system. Bass extension from the 1-66s is awesome; deep and thrilling, which is ideal for action blockbusters such as Speed, Twister or Titanic (you don't just watch the ship sink - you feel it through the floorboards). The centre channel speaker locks dialogue firmly into place and steers the sound with maximum impact; dialogue in Speed comes across as frantic as the driving. Full marks."

* Figures amended to reflect current pricing.

For the entire transcript of this review or information on our 14 models contact VAF Research and ask for your copy of "What the Critics Say". Free call 1800 818 882. Email vaf@vaf.com.au or surf www.vaf.com.au

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